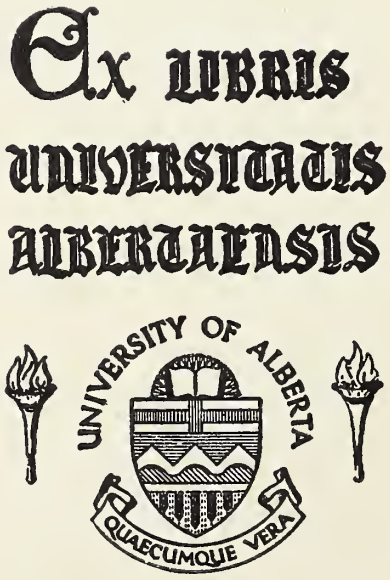
For Reference

NOT TO BE TAKEN FROM THIS ROOM

For Reference

NOT TO BE TAKEN FROM THIS ROOM



University of Alberta
Printing Department

Digitized by the Internet Archive
in 2018 with funding from
University of Alberta Libraries

https://archive.org/details/somegeographical00seal

THE UNIVERSITY OF ALBERTA

SOME GEOGRAPHICAL ASPECTS OF THE COAL INDUSTRY IN ALBERTA

by

Ronald Gordon Seale

A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE

OF MASTER OF ARTS

DEPARTMENT OF GEOGRAPHY

Edmonton, Alberta

April, 1966

Abstract

Coal mining has been an important industry in Alberta for over seventy-five years. Two distinct mining regions have developed --the mountain region and the plains region.

The coal of the mountain region is largely bituminous in rank. Geological conditions are quite adverse, with steeply pitching seams adding greatly to extraction costs. Large scale operations have been the rule in the mountains and many communities of 1,500-4,000 persons have arisen which have been dependent almost entirely on the coal industry. The railroad market was dominant for the mountain mines.

In contrast the coal of the plains is sub-bituminous in rank and occurs generally in flat-lying seams. Although there have been and are now some large mines on the plains, the majority have been very small-scale operations with work forces of less than twenty. It follows that communities wholly dependent upon the coal industry were much less common on the plains than in the mountains. The household fuel market was of over-riding importance for the plains mines, with many of them disposing of their entire output over a limited local area. This pattern gave rise to the term "wagon mine" as opposed to a mine which shipped to distant markets by rail.

Since 1950 technological changes have brought about great changes in Alberta's coal industry. Use of diesel locomotives by the railroads destroyed the major market of the mountain mines, and the use of natural gas and fuel oil as household fuels similarly destroyed the major market of the plains mines. As a result the industry was severely depressed in the 1950s.

However the picture is now beginning to improve, with production in both regions increasing. Metallurgical markets, particularly in Japan, are the basis of growth in the mountain region. On the plains the new orientation is to thermal power generation. It is expected that other new markets will arise which utilize coal's chemical and structural properites rather than its combustibility, and will involve more secondary processing in Alberta.

Current growth of the coal industry is also due to technological improvements in coal extraction methods, particularly in the stripping operations of the plains. The emphasis on mechanized mining and secondary processing reflects a basic change from a labor intensive to a capital intensive industry. These trends, plus the increasing diversification of Alberta's economy, would seem to indicate that despite its revival, the coal industry of this province is unlikely to give rise to any new communities which are distinctively "coal towns" such as those of the Coal Branch in the 1930s and 1940s.

Acknowledgments

In preparing this study I have been given valuable assistance by Mr. J. D. B. Brown, Assistant Director of the Mines Division, Alberta Department of Mines and Minerals. I should like to thank him for his co-operation in enabling me to make use of the materials of The Mines Division. Many persons whose connections with the coal industry are widely varied have also assisted me. I wish to express particular appreciation to Dr. Norbert Berkowitz, Head, Coal Research Division, Research Council of Alberta; Mr. J. G. MacGregor, Chairman, Alberta Power Commission; and Mr. O. H. Patrick, General Manager, Amalgamated Coals, East Coulee, Alberta.

I am grateful to my supervisor, Dr. R. G. Ironside, for his encouragement and constructive criticism of the study. Thanks are due Mrs. T. P. Robertson for her competent typing of the thesis and to Mr. Jack Chesterman for reproduction of the figures.

Ronald Gordon Seale.

TABLE OF CONTENTS

Page

ABSTRACT..... iii

ACKNOWLEDGMENTS..... v

TABLE OF CONTENTS..... vi

LIST OF FIGURES..... xvi

LIST OF TABLES..... xviii

LIST OF PLATES..... xx

LIST OF ABBREVIATIONS USED..... xxi

INTRODUCTION..... xxii

CHAPTER

I. GEOLOGY AND COAL..... 1

I. The Nature of Coal and its Formation..... 1

II. The Location and Character of Alberta Coal Formations..... 3

A. Lower Cretaceous Coals..... 3

1. The Kootenay Formation..... 3

2. The Luscar Formation..... 5

B. Upper Cretaceous Coals..... 5

1. The Belly River Series..... 6

2. The Edmonton Formation..... 6

C. Other Formations..... 8

III. The Alberta Syncline..... 9

Page

IV. Geological Conditions and Mining Costs..... 10

A. Tectonics..... 10

B. Other Geological Factors..... 15

V. Classification of Alberta Coals..... 18

VI. Properties of Coal in Relation to Specific Uses..... 21

VII. Alberta Coal Reserves..... 26

II. RAILROADS AND COAL..... 35

I. The Effect of Railroads on the Establishment of Coal Mining on the Plains..... 36

A. Edmonton..... 36

B. Drumheller..... 37

C. Lethbridge..... 38

II. The Effect of Railroads on Coal Mining in the Mountains..... 40

A. Transcontinental Routes..... 40

B. The Position of Railroads in Studies of the Geological Survey of Canada..... 41

C. The Coal Branch and Nordegg.. 43

D. The Crowsnest Pass..... 45

III. The Importance of Coal Mines to the Railroads..... 46

A. The Construction of the Railroads..... 46

B. Coal Traffic..... 48

IV. Availability of Rolling Stock for Coal Movements..... 49

Page

V. The Importance of Railroads to Alberta Mines..... 52

A. The Pre-War Market..... 52

B. Dieselization..... 56

VI. The Present Relationship Between Coal and the Railroads..... 60

A. Freight Rates..... 61

B. Rail Subsidies on Transport of Coal..... 63

1. Social Reasons for Coal Subsidies..... 65

2. Problems in Re-opening Abandoned Mines..... 66

3. National Security..... 66

4. Coal's Importance to the Railways..... 67

5. Regional Aid..... 67

6. Possible Means of Aiding the Coal Industry.... 68

7. Implementation of Rail Subsidies..... 68

a) The Amount of Subsidization.... 69
b) Subsidized Exports..... 70
c) The Success of Coal Subsidies... 71
d) Tenure of Subsidies.. 71

C. Rationalization of Rail Transport.. 72

D. The Coal-fired Gas Turbine..... 74

III. INDUSTRIAL STRUCTURE AND THE TECHNOLOGY OF COAL PRODUCTION..... 76

I. The Scale of Operations..... 76

Page

II. Mechanization of Mining..... 84

A. The Financial Barrier..... 84

B. Physical Barriers..... 85

C. Advances During and Since World War II..... 88

III. Strip Mining..... 89

A. The Development of Strip Mining Machines..... 89

B. Physical Conditions..... 92

1. The Strip Ratio..... 92

2. Drainage..... 92

3. Slope..... 93

C. Development of Strip Mining in Alberta..... 94

D. Strip Mining at Wabamun..... 98

IV. Other New Mining Techniques..... 100

A. Hydraulic Mining..... 100

B. Coal Planing..... 103

C. Prospects for the Future..... 104

IV. TECHNOLOGICAL CHANGE AND THE MARKETS FOR COAL... 106

I. The Household Fuel Market..... 107

A. Seasonality of Operations..... 108

B. Competitive Fuels..... 109

1. Natural Gas..... 111

2. Fuel Oil and Propane... 114

Page

C. Coal's Future Position in the Household Fuel Market..... 115

1. Alberta..... 118

2. Saskatchewan..... 118

3. Manitoba..... 120

4. British Columbia..... 120

5. The World Picture..... 120

D. Electricity in Space Heating... 123

1. Hydro Power and Coal Power..... 123

2. Nuclear Power..... 124

II. New Markets for Coal..... 127

A. Changing Attitudes Toward Coal..... 128

B. Coke..... 129

C. The Carbochemical Industry..... 135

1. Carbonization..... 138

2. Gasification..... 139

3. Hydrogenation..... 139

4. Active Carbons..... 141

5. Molecular Sieves..... 143

6. Coal-based Fertilizers.. 143

D. Structural Carbons..... 144

E. A Capital Intensive Coal Industry..... 144

Page

V. EXTENDING THE MARKET FOR COAL..... 147

I. Coal Preparation..... 147

A. Briquettes..... 147

1. The Briquetting Process 148

2. Briquetting Plants in Alberta..... 149

3. Markets for Briquettes. 151

B. Mechanized Mining and the Need for Coal Preparation..... 151

C. Quality Requirements for Current Markets..... 153

II. Changing Distribution Patterns for Alberta Coal..... 155

A. Western Canada Markets..... 156

B. The Ontario Market..... 157

C. The Export Market..... 158

1. The United States..... 158

2. Japan..... 160

III. Coal Pipelines..... 162

A. Methods of Pipelining Coal..... 163

B. Comparative Costs of Transporting Coal by Rail and by Pipeline 164

C. The Japanese Market..... 167

D. The Ontario Market..... 168

E. Coal Pipelines and Industrial Location..... 168

F. The Future for Coal Pipelines.. 169

Page

VI. COAL AND ELECTRIC POWER GENERATION..... 170

I. The United States..... 170

II. Canada..... 170

III. Alberta..... 173

A. Growth Rates of Power Generation and Coal Consumption..... 173

B. Power Generation from Other Sources..... 174

1. Oil and Natural Gas.... 174

2. Hydro Power..... 176

3. Nuclear Power..... 180

4. The Athabaska Tarsands.. 181

5. The Future for Alberta Coal in Power Generation..... 181

C. Coal-fired Power Stations in Alberta..... 182

1. Locational Factors..... 182

2. Drumheller Power Station..... 185'

3. Sentinel Power Station..... 186

4. Possible Locations for Coal-fired Power Stations..... 186

5. Additions to Edmonton's Power Generating Facilities..... 187

6. A National Power Grid.. 189

Page

VII. SETTLEMENT AND LABOR PATTERNS..... 192

I. Discovery of Alberta Coal Deposits..... 192

II. The Coal Industry and Rural Settlement. 195

III. The Character of Coal Mining Centers on the Plains..... 196

IV. Seasonality of the Plains Mines..... 198

A. Pre-war Conditions..... 198

B. The Post-war Period..... 200

V. Integration of Mining and Farm Labor... 205

VI. The Effect of Coal Mining on Settlement in the Mountains..... 206

A. Labor Requirements in the Mountain Mines..... 207

B. The Dominant Position of the Coal Industry..... 208

C. The Importance of Isolation.... 209

D. The Company Town..... 210

E. Settlement Patterns..... 210

F. Impermanence of Settlements.... 211

G. Social Consequences of Mine Closures..... 211

VII. Seasonality in the Mountain Mines..... 214

VIII. Labor-Management Relations..... 217

IX. Productivity..... 219

A. The Pre-war Situation..... 219

B. World War II and the Growth of Stripping..... 221

Page

C. Underground Mining in the Post-war Period..... 222

D. Possibilities for Improved Productivity in Underground Mines..... 224

1. The Plains Region..... 225

2. The Mountain Region..... 225

X. Size of the Labor Force..... 226

A. The Post-war Decline..... 226

B. Supply and Demand for Labor.... 227

1. The Developmental Stage of the Coal Industry 230

2. The Labor Shortage of the 1940s..... 230

3. Loss of Markets and the Effect on Demand for Labor..... 232

C. Reasons for the Present Labor Shortage..... 233

1. Wages..... 233

2. Coal Mining's Public Image..... 234

3. The Difficulties of Attracting Men into Mining..... 235

4. Age of Miners..... 236

5. Mechanization: A Partial Solution.... 237

XI. The Move Towards a Capital Intensive Industry..... 238

Page

XII. Coal's Present Status as a Stimulus for Regional Development..... 239

A. The Smoky River Deposits..... 239

B. The Improbability of New Coal Towns..... 242

VIII. CHANGING ATTITUDES TOWARDS THE ALBERTA COAL INDUSTRY..... 244

I. Misconceptions Regarding the Coal Industry..... 244

A. Obsolescence..... 244

B. The Effect of Stripping on the Landscape..... 244

C. Population, Industrial Location, and Coal Production..... 246

1. The Relationship Between Population Density and Coal Production. 246

2. The Importance of Raw Materials in Industrial Location..... 247

II. Nationalism and Sentimentality..... 250

A. The Desire to Reduce Imports... 250

B. Nostalgic Thinking in the Formulation of Coal Policy..... 253

III. Conclusions..... 254

following pages

LIST OF FIGURES

1. Cretaceous Paleogeography of North America..... 2
2. Coal Bearing Formations of Alberta..... 3
3. Coal Areas of Alberta..... 3
4. Alberta: Location Map..... 4
5. The Alberta Syncline..... 5
6. Coal Production in Alberta Coal Areas, 1949, 1954, 1959, 1964..... 8
7. Geology and Abandoned Mines, Crowsnest Pass Area.... 11
8. Reserves of Coal in Alberta..... 31
9. Drumheller Coal Area..... 37
10. Smoky River Coalfield and Alberta Resources Railway. 46
11. Coalfields of Canada..... 63
12. Coalfields of Canada, and Principal United States Coalfields Shipping to Canada..... 63
13. Markets for Alberta Coal, 1945-1964..... 63
14. Shipment of Coal Under Subvention from Alberta and the British Columbia Crowsnest for Use in Canada, 1928-29 to 1963-64..... 70
15. Shipment of Coal Under Subvention from Alberta and British Columbia for Export and Use in Ships' Bunkers, 1931-32 to 1963-64..... 70
16. Subvention Per Ton on Coal Shipped from Alberta and British Columbia, 1928-29 to 1963-64..... 71
17. Employment in Alberta Coal Mines, 1949, 1954, 1959, 1964..... 78

following pages

18. a) Employment in Alberta Coal Mines, 1906-1964,..... 78

b) Coal Production in Alberta, 1906-1964

19. Number of Producing Mines and Output by Size of Mine, 1949..... 81

20. Number of Producing Mines and Output by Size of Mine, 1964..... 81

21. a) Number of Coal Mines Operating in Alberta, 1906-1964..... 81

b) Types of Coal Mines Operating in Alberta, 1945-1964

22. Location of Coal Mines in Alberta, 1949..... 81

23. Location of Coal Mines in Alberta, 1964..... 81

24. Disposition of Alberta Coal, 1949..... 108

25. Disposition of Alberta Coal, 1964..... 108

26. Energy Sources in Canada, 1941-1963..... 110

27. a) Briquette Production in Alberta, 1907-1964..... 130

b) Coke Production in Alberta, 1905-1964

28. Productivity in Alberta Coal Areas, 1949, 1954, 1959, 1964..... 219

29. Productivity in Alberta Coal Mines, 1927-1964..... 219

30. Mineral Production in Alberta's Economy, 1935-1962.. 256

Page

LIST OF TABLES

TABLE		
I.	CLASSIFICATION OF ALBERTA COAL.....	19
II.	CARBON CONTENT OF COAL.....	20
III.	DOWLING'S ESTIMATE OF ALBERTA COAL RESERVES.....	28
IV.	RESERVES OF COAL.....	32
V.	PERCENTAGE OF ALBERTA BITUMINOUS OUTPUT SOLD TO RAILROADS, 1920-1925.....	52
VI.	PERCENTAGE OF ALBERTA COAL SOLD TO RAILROADS, SELECTED YEARS, 1928-1934.....	55
VII.	RAILROAD LOCOMOTIVES IN USE IN WESTERN CANADA.....	58
VIII.	CLASSIFICATION OF ALBERTA COAL MINES BY TONNAGE, SELECTED YEARS, 1949-1964.....	82
IX.	RESIDENTIAL AND COMMERCIAL FUEL REQUIREMENTS IN THE PRAIRIE PROVINCES.....	119
X.	UNITED STATES CONSUMPTION OF FUELS FOR ALL RESIDENTIAL USES, 1960, AND PROJECTIONS FOR 1980 and 2000	122
XI.	ALBERTA'S BRIQUETTE OUTPUT AND THE IMPORTANCE OF THE RAILROAD MARKET FOR SELECTED YEARS, 1943-1955	152
XII.	GENERATION OF ELECTRICITY IN THE UNITED STATES....	171
XIII.	POWER GENERATION IN ALBERTA BY PER CENT OF SOURCE.	179
XIV.	PERCENTAGE OF CAPACITY USED IN REPRESENTATIVE PLAINS MINES, 1921, 1923, 1924.....	201
XV.	DISTRIBUTION OF SHIFTS WORKED, SAMPLE MINES OF THE PLAINS REGION FOR SELECTED YEARS, 1931-1944.....	202
XVI.	PERCENTAGE OF CAPACITY USED IN REPRESENTATIVE MOUNTAIN MINES, 1921, 1923, 1924.....	215
XVII.	DISTRIBUTION OF SHIFTS WORKED IN SAMPLE STEAM COAL MINES OF ALBERTA AND SOUTHEASTERN B.C. FOR SELECTED YEARS, 1931-1944.....	216
XVIII.	PRODUCTIVITY IN LEADING ALBERTA STRIP MINES, 1944.	223

Page

XIX. NUMBER OF PERSONS EMPLOYED IN COAL MINES OF THE MOUNTAIN REGION FOR SELECTED YEARS, 1939-1963..... 228

XX. NUMBER OF PERSONS EMPLOYED IN LEADING COAL MINING DISTRICTS OF THE PLAINS REGION, 1939-1963..... 229

following pages

LIST OF PLATES

PLATES

I. STRIP MINING IN THE BATTLE RIVER COALFIELD..... 98

II. WABAMUN COALFIELD..... 99

III. BANKHEAD..... 108

IV. CANMORE..... 108

V. MINES IN THE DRUMHELLER COAL AREA..... 197

VI. SETTLEMENT FEATURES IN THE DRUMHELLER COAL AREA.. 198

VII. INFLUENCE OF STRIP MINING ON THE LANDSCAPE..... 244

LIST OF ABBREVIATIONS USED

I. ORGANIZATIONS.

a)	C.N.R.	Canadian National Railways
b)	C.P.R.	Canadian Pacific Railway
c)	G.S.C.	Geological Survey of Canada
d)	G.T.P.R.	Grand Trunk Pacific Railway
e)	H.B.C.	Hudson's Bay Company
f)	R.C.A.	Research Council of Alberta
g)	U.M.W.A.	United Mine Workers of America

II. PUBLICATIONS.

a)	A.A.A.G.	Annals of the Association of American Geographers.
b)	C.M.M.B.	Canadian Mining and Metallurgical Bulletin
c)	Econ. Geogr.	Economic Geography
d)	T.C.I.M.M.	Transactions of the Canadian Institute of Mining and Metallurgy

INTRODUCTION

In the post-war period much of the interest in Alberta's economy has been centered on the burgeoning petroleum industry. As a result the coal industry has often been relegated to the background. Yet it still plays an important role in the province's economy and its varied development makes it an interesting subject of study. Unlike the petroleum industry which has experienced almost constant growth, the coal industry has had a checkered history of boom and bust. Geographical relationships involving such things as labor, productivity, transport, and markets have all undergone significant changes in the course of the development of the industry.

Aims

Technological advances have thus considerably altered the means of production, distribution and consumption of coal in Alberta. The chief aims of this thesis are to examine some of the geographical relationships of the industry and to determine how present patterns of production, distribution, and consumption, differ from those prevailing before the post-war technological changes.

Scope

Several areal units might be used as the bases of a study of this kind. There are certain advantages to limiting the discussion to one mine or to one mining region such as the Coal Branch. However there has not been uniform development of the coal industry in Alberta. Instead, progress in some production centers has coincided

with marked decline in others. If the discussion were restricted to one mine or one region, such important differences and the reasons for them would not be readily apparent. Moreover, important inter-relationships between mining areas would not be brought out.

On the other hand, it might well be argued that a wider base than Alberta would be useful. Such a base would presumably include the coal-producing districts of British Columbia and Saskatchewan. However the types of operations which are present in the other two provinces all occur within Alberta. Hence restriction of the study to Alberta alone does not exclude any significant patterns.

The most important western Canadian coal producing district outside Alberta has been the British Columbia section of the Crowsnest. There are grounds for including it in this study, particularly since it is contiguous with a major area of production in Alberta. Statistics compiled on a provincial basis, however, make inclusion of the B.C. Crowsnest impractical. Moreover, as will be demonstrated below, there are some important aspects of the coal industry in which very little contact occurs between the two sections of the Crowsnest. There are thus theoretical as well as practical grounds for exclusion of the B.C. section.

Methodology

The geographical approach is particularly suited to a study of the coal industry. Until very recently the latter has been definitely labor intensive. It has thus been of considerable importance in the development of patterns of population distribution

within the province. In some of the mountain areas the coal industry was the major stimulus promoting settlement in areas which otherwise would have remained unpopulated.

Some aspects of physical geography are also of importance with respect to the coal industry. The obvious one is occurrence of the mineral resource. Others include the influences of slopes and drainage on strip mining.

The coal industry continues to play an important role in development of transport facilities in Alberta. This is particularly true with respect to railroads. Also, any future development of solids-pipelining will be closely connected with the marketing of coal.

Coal is an important factor in certain locational patterns in industrial geography. This is especially true in the field of power generation. Coal-fired thermal power stations are becoming increasingly important in Alberta.

Most studies of Alberta's coal industry have been done in the fields of either geology or economics. Most of the former have been relatively detailed monographs concerned primarily with the geology of limited areas and only in a secondary manner with the problems of production, distribution, and consumption of the coal. In effect, they have been microscopic in nature and to some extent constitute a series of case-studies. It is felt, however, that an integrated wholistic study is necessary in order to compare and contrast the geographical relationships in different mining regions within Alberta.

The economic studies, in contrast, have been largely macroscopic in nature, dealing with the entire province or even with the whole of Canada. Too often such studies fail to make clear the very real differences existing between various producing districts within Alberta. It is hoped that in the present study and the figures which accompany it, such differences will be readily apparent.

Techniques.

Library research has been very important in the preparation of this thesis. Major source materials have included publications of the Geological Survey of Canada and of the Research Council of Alberta. Among the economic studies used, the most important have been works down in connection with the many Royal Commissions done on coal, in both provincial and federal spheres. Technical and trade journals from the fields of mining and metallurgy were utilized. The records of the Mines Branch, Alberta Department of Mines and Minerals, have also proved invaluable, particularly as a source of statistics utilized in the accompanying figures.[1]

Personal interviews have been an important source of material. Representative opinions were obtained from persons engaged in coal production in most of Alberta's leading Coal Areas including Crowsnest and Cascade, Pembina and Castor, Drumheller and Lethbridge. Among others

---

[1] Unless otherwise indicated, statistical material in the text is taken from the records, both published and unpublished, of the Mines Branch, Alberta Department of Mines and Minerals.

interviewed were representatives of the electric power industry, the Coal Division of the Research Council of Alberta, and the Mines Branch of the Alberta Department of Mines and Minerals.

Material gathered from these sources has been used to attempt to show, both in text and graphical representation, the changes which have occurred in some of the geographical aspects connected with the coal industry in Alberta during the post-war period. An attempt has also been made to suggest what form these geographical patterns might take in the future.

CHAPTER I

GEOLOGY AND COAL

I. The Nature of Coal and Its Formation.

Coal is a dark-colored combustible rock. It can be either sedimentary or metamorphic. It is not a mineral since a mineral has a regular or characteristic internal structure, consequent on a regular arrangement of atoms or ions within it. This regular structure gives a mineral chemical and physical properties which vary only within certain well-defined limits. Coal on the other hand, occurs in many different forms and has a correspondingly wide range of properties. It is in fact an aggregate of macerals which are the optically differentiated components equivalent to the minerals of inorganic rocks. Coal's properties, therefore, depend on the relative proportions of its component macerals and its elemental composition.

The energy which is derived from the combustion of coal was originally solar energy. Through the process of photosynthesis, this energy was transformed into chemical energy and stored in plants. Thus coal originated as vegetal matter in the geologic past. In the Northern Hemisphere the two most significant periods with respect to the growth of plant matter which eventually gave rise to coal deposits were the Carboniferous and the Cretaceous. The environments in which these plants grew were very swampy and when the plants died they were subject to geologic burial rather than to decay in contact with the atmosphere. Thus excluded from ready oxidation in the air, some of the plant components gradually changed through biochemical processes and later through heat and the pressure created

by successive sedimentary layers into solid products, notably fixed carbon, the most significant element in coal.

Of the two major coal-forming periods only the more recent of the two, the Cretaceous, is significant in Alberta. Virtually all Alberta's coal was deposited in the Cretaceous, though some did originate immediately before the Cretaceous in the late Jurassic and some immediately after the Cretaceous in the early Tertiary.

The typical environments of the plant forms from which Alberta coal originated were the coastal swamps and tidal flats at the edge of the Cretaceous sea (see Fig. 1). However one of the most characteristic features of the Cretaceous was the impermanence of land masses and water bodies. Thus "the edge of the Cretaceous sea", was continually fluctuating, particularly during the upper Cretaceous. Conditions suitable for the growth of coal-forming plants in the Cretaceous were therefore intermittent, widely separated, and often of short duration. This fact is of great importance with respect to the economic status of Alberta's coal industry. Because of the instability of their environment, the Cretaceous plants were generally small, in contrast to the giant forms of the Carboniferous from which the Appalachian coals originiated. Moreover the instability of Cretaceous shorelines meant that the coal deposits originating from plants growing on these shorelines were often thin and discontinuous compared to the deposits of the Carboniferous. These discontinuities add greatly to the extraction costs of Alberta coal,

Figure 1: Cretaceous paleogeography of North America. A, left, late in the Early Cretaceous Epoch; B, right, a composite for Late Cretaceous time showing the maximum submergence.

Source: C. O. Dunbar, Historical Geology, New York, 1960, p. 320.

and often set a ceiling upon the degree of mechanization which is economically feasible in the mines of this province. It is economically significant that such discontinuities are much less often encountered in the Appalachian coalfield, Alberta's main competitor in the large and lucrative eastern Canadian market.

As a result of the extent and instability of the Cretaceous seas, much of the southern half of Alberta is underlain by coal. Great variety exists in the type of coal present. All ranks from lignite to semi-anthracite occur in Alberta. Rank is partly a product of age, i.e., of time of deposition. In this respect several distinct coal-bearing formations are recognized in Alberta representing different times of deposition.

II. The Location and Character of Alberta Coal Formations

The oldest Alberta coals (with the exception of very small deposits apparently belonging to the very late Jurassic) are Lower Cretaceous. They occur chiefly in two formations which are exposed in the eastern or front ranges of the Rockies (see Fig.2). The Kootenay Formation is present from the Crowsnest Pass area to the Panther River area north of Banff. The Luscar Formation occurs from the Clearwater to the Smoky River area (see Fig. 3).

A. Lower Cretaceous Coals

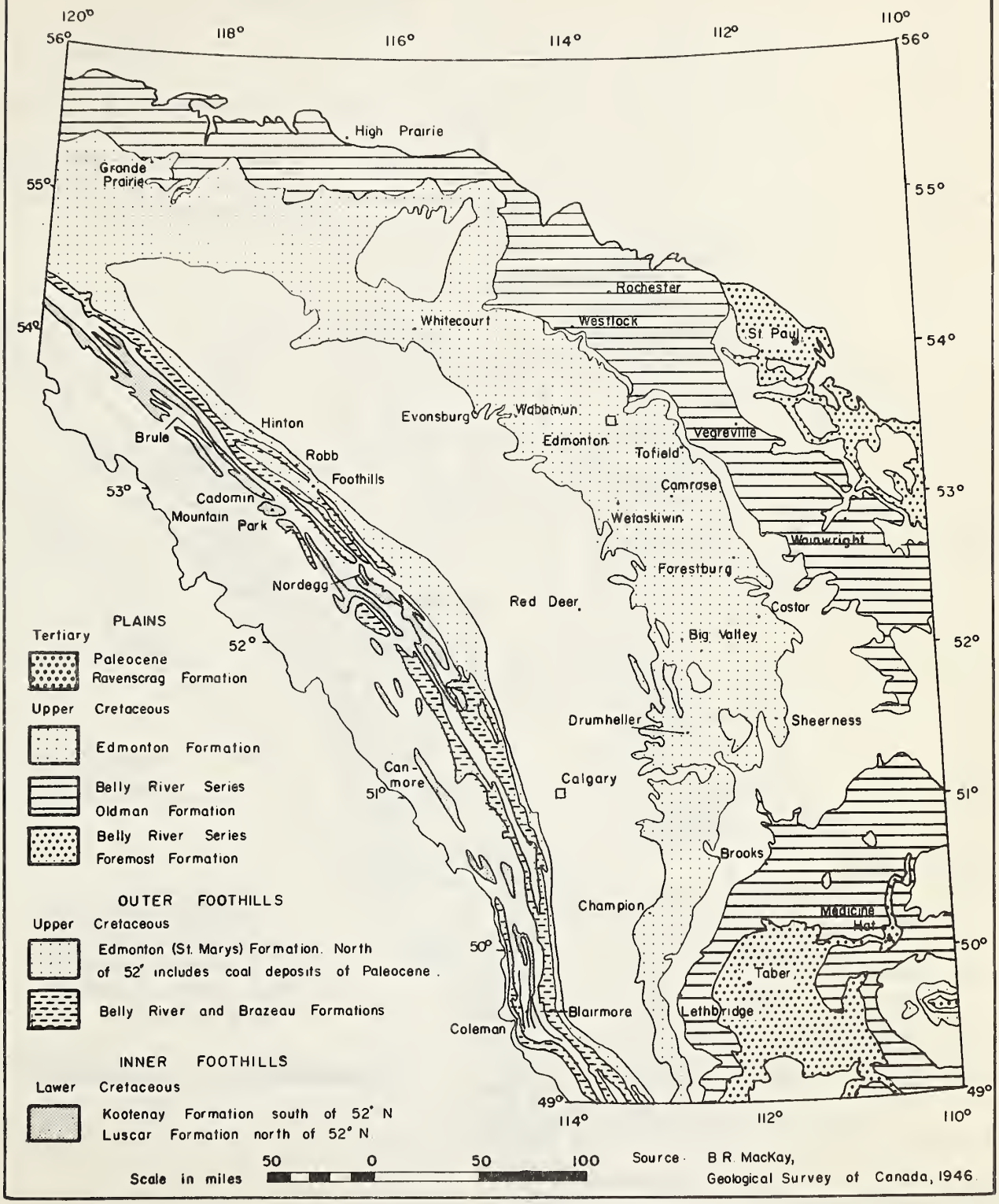
1. The Kootenay Formation. The name Kootenay Formation was introduced by George M. Dawson[1] in 1885 for a coal-bearing series

---

[1]Dawson was one of the many distinguished scientists with the Geological Survey of Canada (G.S.C.) whose work, particularly in the period 1880-1930, greatly increased knowledge of Alberta's geography and geology. Others include D. B. Dowling, R. C. McConnell, and more recently B. R. MacKay.

FIG. 2

COAL BEARING FORMATIONS OF ALBERTA



Source: B.R. MacKay, Geological Survey of Canada, 1946.

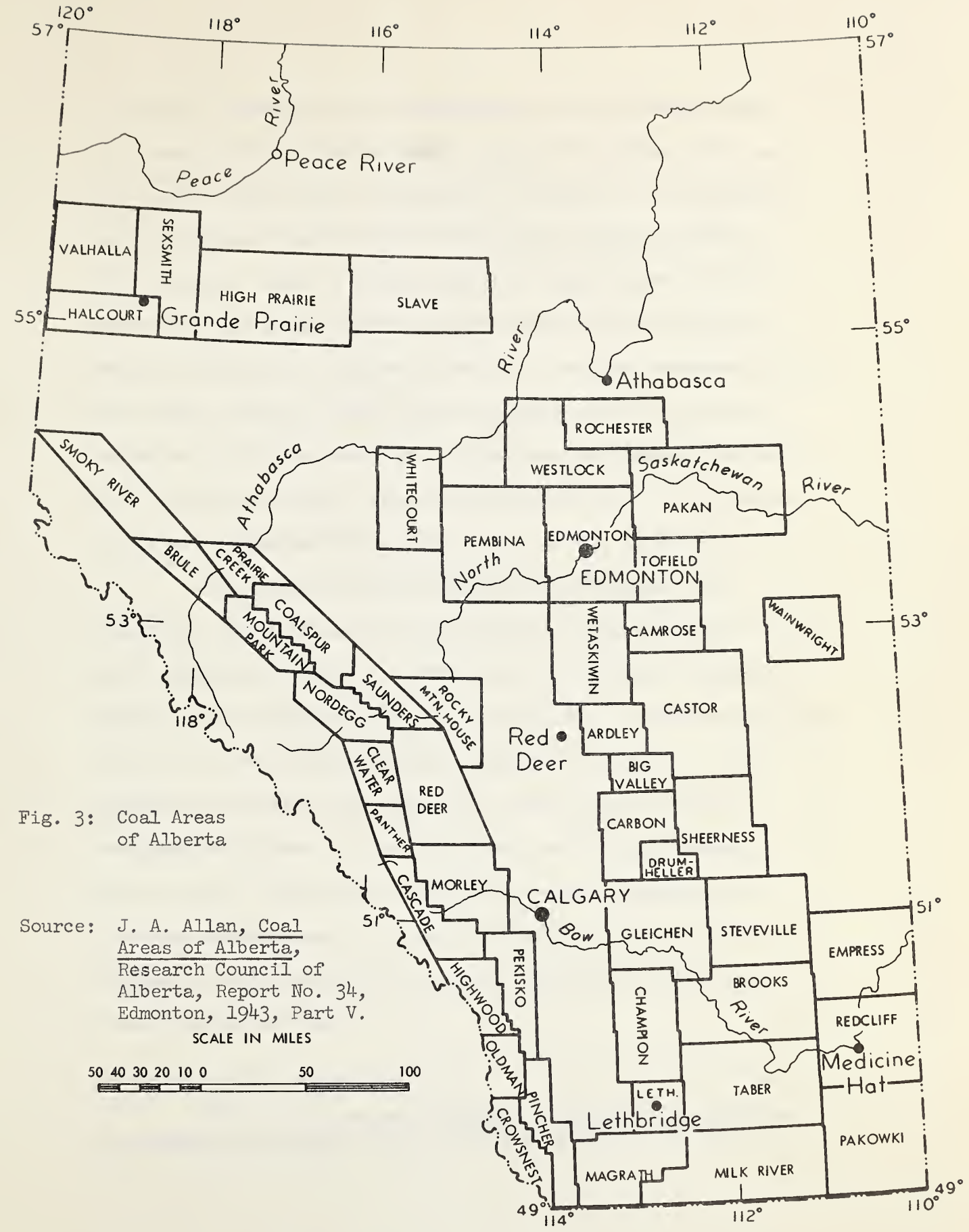


Fig. 3: Coal Areas of Alberta

Source: J. A. Allan, Coal Areas of Alberta, Research Council of Alberta, Report No. 34, Edmonton, 1943, Part V.

of shales, sandstones, and conglomerates in the Crowsnest Pass. This pass is one of the two major areas where Kootenay coal has been and is being mined in Alberta. The extent of the deposits in the Crowsnest district decreases markedly moving eastward from the pass. Thus at Coleman the coal measures are 800 feet thick with five seams totalling forty-seven feet in thickness, whereas at Bellevue, only ten miles east, the coal measures are 430 feet thick, and only three seams are present with a cumulative thickness of thirty-seven feet. Apparently the Kootenay Formation does not extend eastward beyond the plains at all. Its farthest occurrence approximates the eastern edge of the foothills[2].

The other major producing area for Kootenay coal coincides, like Crowsnest, with a Canadian Pacific Railway (C.P.R.) route through the Rockies, in this case the main line through Banff and the Kicking Horse Pass (see Fig. 4). Only one major mine survives in this district--that at Canmore (see Fig. 2). The aggregate thickness of Kootenay coal seams five to ten miles southeast of Canmore is over fifty feet, and in one location a single seam is thirty-four feet thick. Around Canmore itself there are twelve seams of commercial interest, but because of frequent discontinuities, the maximum thickness of any single seam is about ten feet.

---

[2]M. B. B. Crockford, Geology of Kootenay Coal Measures in Southwestern Alberta, Edmonton, 1949, p. 29.

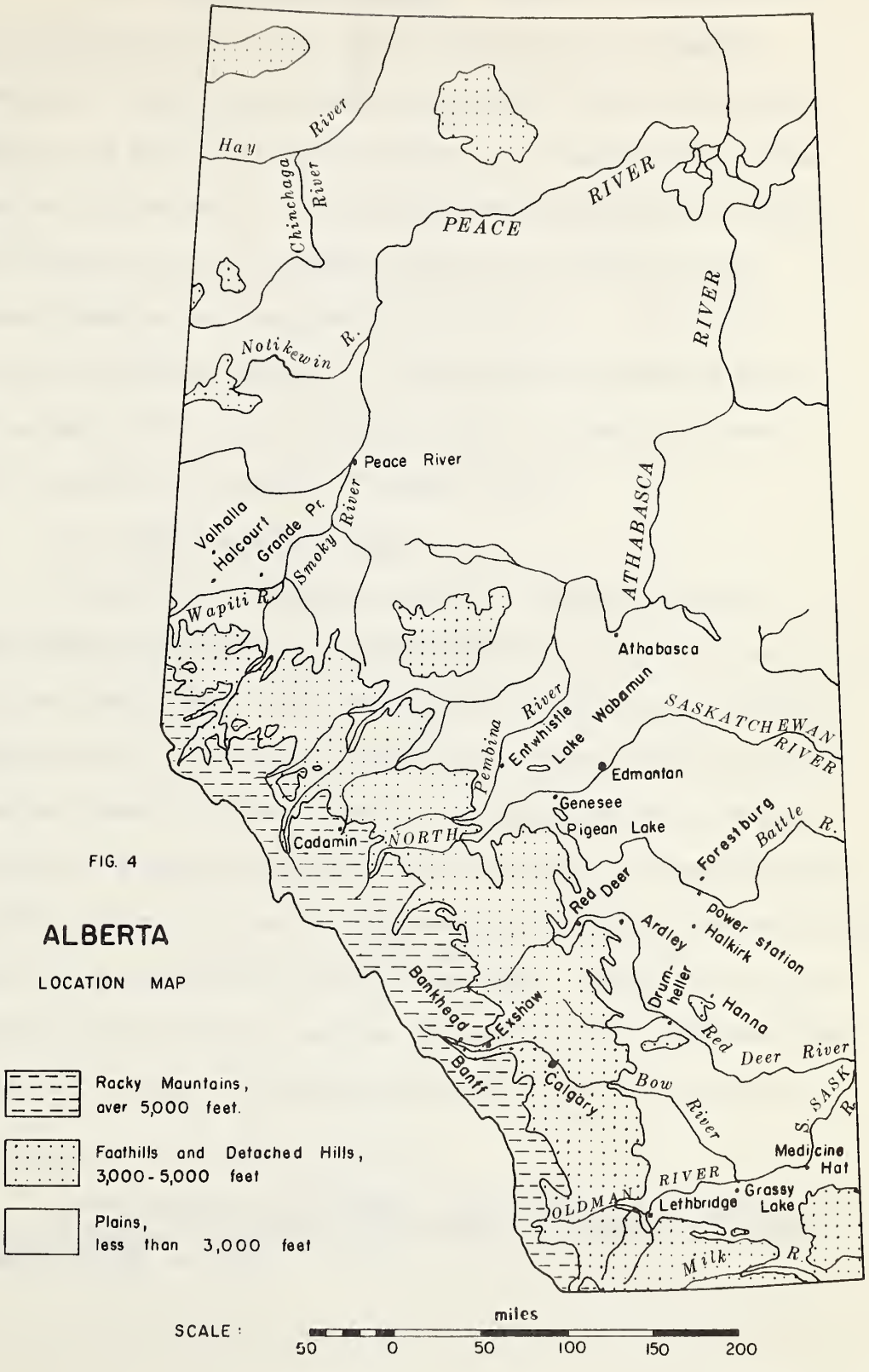


FIG. 4

ALBERTA

LOCATION MAP

Racky Mauntains, over 5,000 feet.

Foothills and Detached Hills, 3,000 - 5,000 feet

Plains, less than 3,000 feet

SCALE : miles

50 0 50 100 150 200

2. The Luscar Formation. Alberta's second major coal-bearing horizon of the Lower Cretaceous is the Luscar Formation. Coal from the latter was mined in the Mountain Park, Cadomin, and Brûlé districts (see Fig. 2). Large deposits also exist to the northwest in the Smoky River-Wildhay River country. One of the first men to examine closely the deposits of the Luscar Formation was John MacVicar of the G.S.C. From 1910 to the mid 1920s he carried out field work from Mountain Park to the Smoky River, and at Mountain Park he noted eight seams with a cumulative thickness of seventy feet.[3]

B. Upper Cretaceous Coals

These Lower Cretaceous coals are separated from the Upper Cretaceous deposits by great thicknesses of marine shales with some sandstones. When the Cretaceous sea finally retreated, conditions were suitable for deposition of Upper Cretaceous coal in three formations--the Foremost, the Oldman, and the Edmonton, in order of deposition (see Fig. 2). The coals of these formations are often referred to as the plains coals in contrast to the mountain coals of the Kootenay and Luscar Formations. The plains coals are generally flat-lying but they may dip at up to 5°. They cover wide areas on the eastern slope of the Alberta Syncline (see Fig. 5).

---

[3]John MacVicar, The Origin, Composition and Occurrence of Coal in Alberta, unpublished M.Sc. Thesis, University of Alberta, Edmonton, 1916, p. 120.

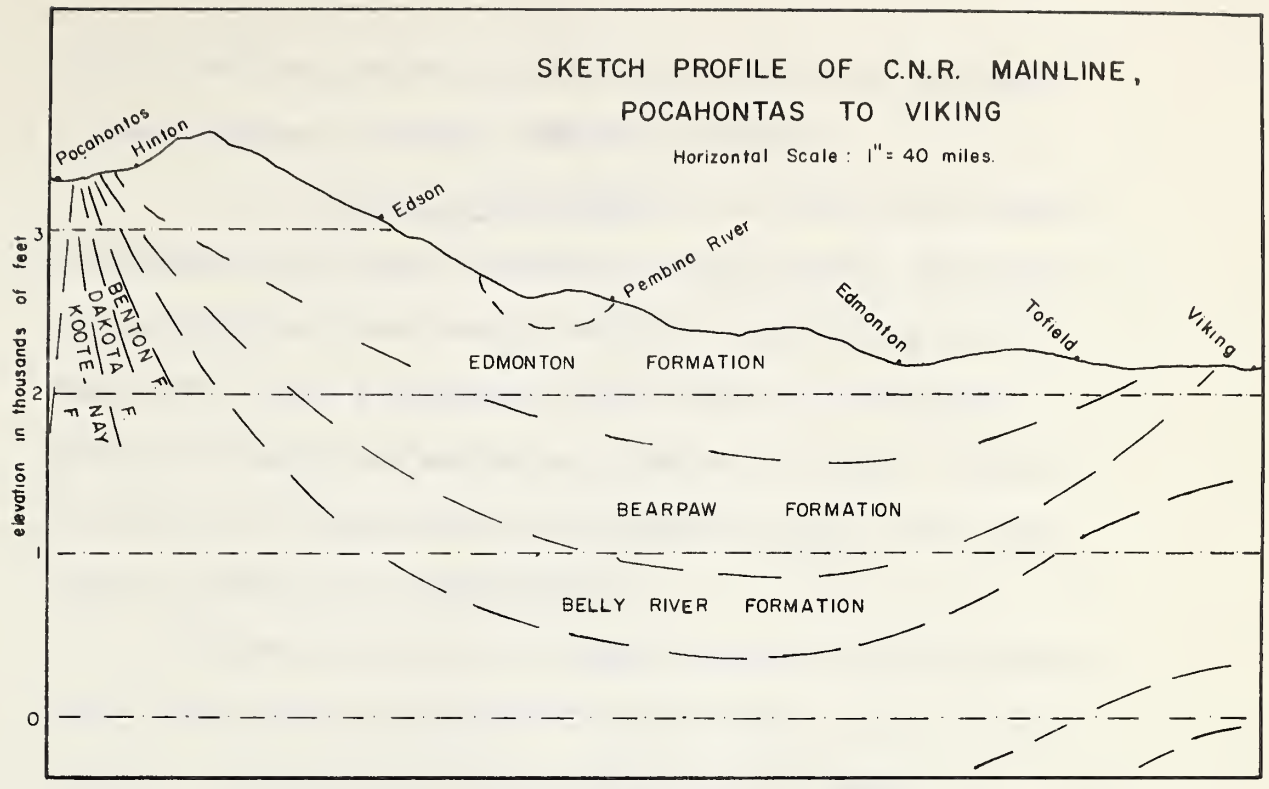
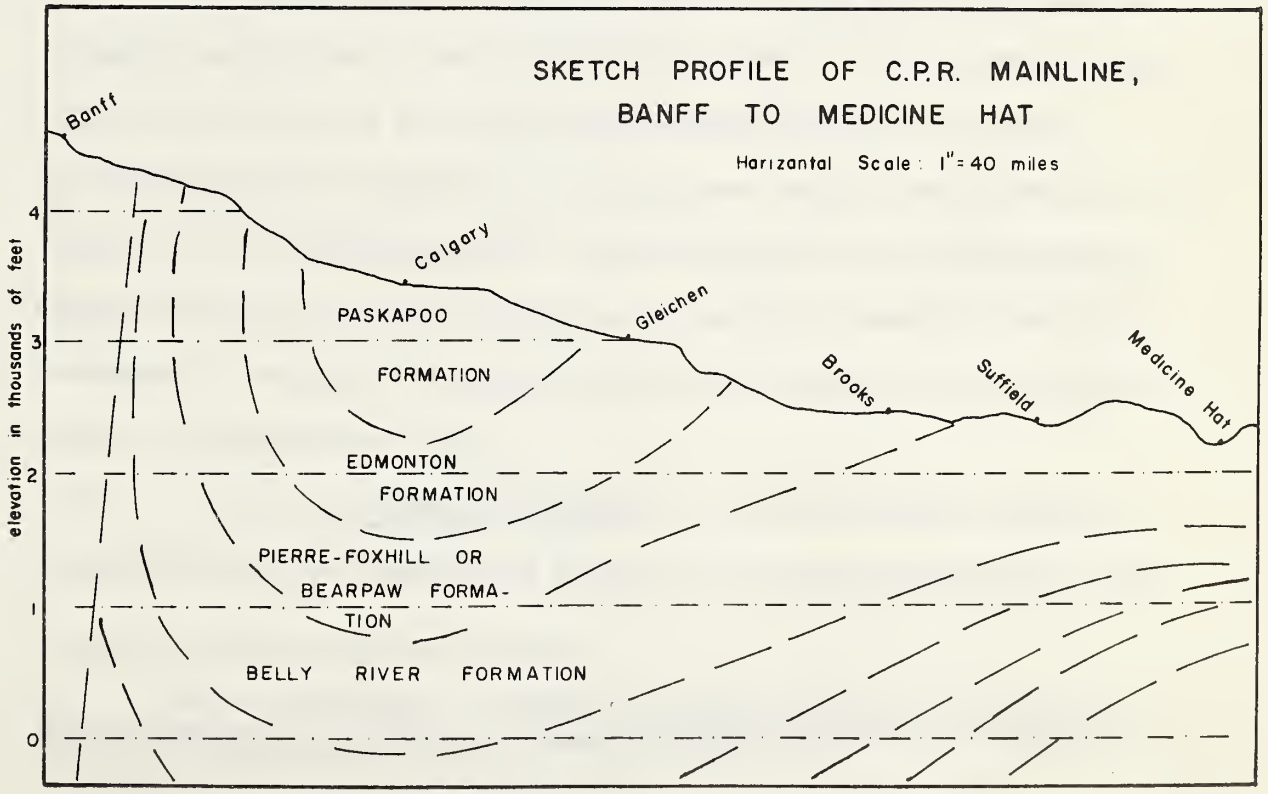


FIG. 5 **THE ALBERTA SYNCLINE**

Source: J. MacVicar, The Origin, Campasition, and Occurrence af Coal in Alberta, Edmantan, 1916.



Although they are commonly found at the surface, the overburden in some cases may be several thousand feet thick.

1. The Belly River Series. The distinction between the Foremost and Oldman Formations is often ignored, especially in the foothills, where the two are known collectively as the Belly River Series or Formation. This freshwater formation consists of sandstones and shales in addition to coal. Areally it extends over approximately 26,000 square miles, a very small portion of which is in Saskatchewan.

In terms of Alberta's economic history, the most important Belly River coal has been that of the Lethbridge district (see Fig. 3). The Lethbridge seam is about 4.5 feet thick.

Belly River coals as well as deposits from the lower Edmonton Formation also occur in the Peace River district, in the Wapiti River valley (see Figs. 2 & 4). As in the southern plains, the strata are generally flat-lying but in the southwest part of the district, dip slopes of 18° are encountered.[4] Close proximity to the Rockies, which were the center of orogenic activity, was mainly responsible for these conditions. Coal has been mined in the Wapiti district since 1916, but never on a significant scale.

2. The Edmonton Formation. The most recently deposited Cretaceous coals of Alberta are those of the Edmonton Formation. The

---

[4]J. A. Allan and J. L. Carr, Geology and Coal Occurrences of Wapiti-Cutbank Area, Alberta, Edmonton, 1946, p. 7.

latter consists of fine-grained argillaceous material, shales, and sandstones, all deposited during the retreat of the Bearpaw Sea. Over much of Alberta a substantial portion of the Edmonton Formation has been removed by post-depositional erosion, particularly during the Pleistocene. Yet the coal measures of this formation still extend over an area of approximately 27,000 square miles within Alberta, or slightly more than the area underlain by Belly River coals (see Fig. 2).

Coal from the Edmonton Formation was utilized before 1850 in the Edmonton district itself. Existence of the coal of this formation in other locations was also known at a fairly early date. However the first geological investigations were apparently carried out by Selwyn who in fact named the Edmonton Formation in 1874. His work was continued by J. B. Tyrrell who concentrated particularly on the Red Deer Valley. He also observed a large seam stretching from near Drumheller in the Red Deer Valley to an outcrop in the valley of the North Saskatchewan, forty-five miles upstream from Edmonton. This seam, known simply as "The Big Seam" since the mid-nineteenth century, has a thickness up to twenty-five feet.

Edmonton Formation coals are of relatively low rank. Indeed in 1908 D. B. Dowling of the G.S.C. classified those of the Edmonton district itself as lignitic.[5] Today they are generally

---

[5]D. B. Dowling, "Steam Coals of the Cascade Basin Lignite Areas of Alberta and Saskatchewan. Production of Coal in Alberta and Saskatchewan", Summ. Report, G.S.C., 1908, p. 81.

classified as subbituminous. They are or have been mined in many districts of Alberta (see Fig. 3). Historically, however, the two areas which were by far the most important producers were Drumheller and Edmonton (see Figs. 3 & 6).

Both have failed to maintain their positions as leading coal producers. Today the two leading districts working coal of the Edmonton Formation are Pembina and Castor. Production in each case is oriented to the supply of raw material for thermal power generation. Should any concrete development arise from current studies of the Ardley coalfield a third large-scale producer of Edmonton Formation coal would join Pembina and Castor (see Fig. 3).

C. Other Formations.

In addition to these major Cretaceous coal formations, there are also considerable deposits of Tertiary coal in Alberta. They occur in the Cypress Hills and at several locations in the plains and outer foothills (see Figs. 2 & 4). All are Paleocene in age, equivalent to the lignite deposits of Saskatchewan. Commercially, the most important Tertiary deposits are those of the outer foothills between Hinton and Nordegg in the Prairie Creek, Coalspur, and Saunders Creek Coal Areas.[6] On the plains, Tertiary deposits occur between Red Deer and Ponoka (see Figs. 2, 3, & 4).

---

[6]"Coal Areas" are administrative and statistical units. They were originally drawn up by Dr. John Allan in 1924. The boundaries (see Fig. 3) are arbitrary but are based to some extent upon geological formations and upon chemical characteristics of the coal. See John A. Allan, Coal Areas of Alberta, Edmonton, 1943.

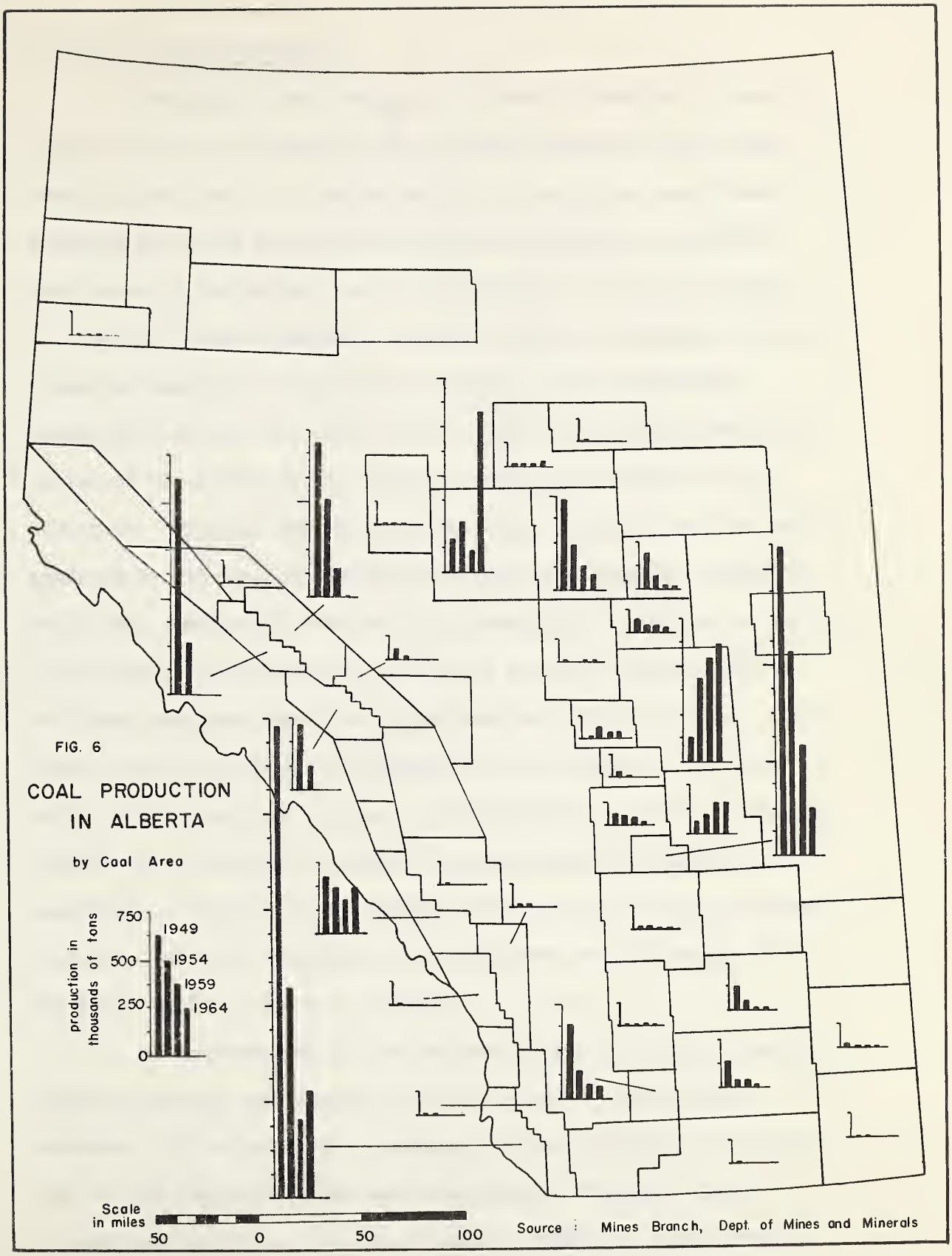


FIG. 6
COAL PRODUCTION
IN ALBERTA
by Coal Area
production in thousands of tons
750
500
250
0
1949
1954
1959
1964
Scale in miles
50
0
50
100
Source : Mines Branch, Dept. of Mines and Minerals

III. The Alberta Syncline.

The key to the location of Alberta's deposits of various types of coal is the large structural basin known as the Alberta Syncline (see Fig. 7). The center of the basin lies near Rocky Mountain House and its axis approximately parallels the Rockies. Thus the axis trends north-south from Alberta's southern boundary to nearly 52° north latitude, shifting then to a northwest-southeast trend and continues on out of the province. The approximate parallelism between the axis of the syncline and the general orientation of the ranges of the Rockies reflects the origin of the structure. Orogenic forces associated with the uplift of the Rockies produced overthrusts in the front ranges and extensive warping in the strata immediately east of the otherthrust. The Alberta Syncline was a product of this warping. Most of Alberta's major deposits of Upper Cretaceous coals are associated with this syncline. Therefore, since the axis leaves Alberta in the vicinity of the upper Wapiti River (see Fig. 4), there is very little coal in the northern half of the province, and almost certainly none of commercial importance. The only known deposits north of 55° are near Halcourt, Valhalla, and the headwaters of the Notikewin and Chinchaga Rivers northwest of Hines Creek (see Fig. 4).

Some knowledge of the orientation of the Alberta Syncline helps to explain the location of the province's various coal measures. It accounts, for example, for the existence of Tertiary coal in the Red Deer-Ponoka area with Upper Cretaceous deposits to both east and west. As in any basin, younger or more recently

deposited rocks occur in the center and older rocks outcrop with increasing distance from the axis.

In the Magrath Coal Area at the south end of the syncline and a considerable distance from the center of the basin, the Belly River Series outcrops along the axis of the Syncline.

Conditions are not uniform on either side of the axis, i.e., one side is certainly not a mirror image of the other. Generally speaking, dip slopes are greater west of the axis than they are to the east. Due to their closer proximity to the center of diastrophism, strata west of the axis have undergone greater pressure. One result of this is that although Belly River coals and Edmonton coals are usually quite distinctly separated (by Bearpaw shales) east of the axis, this separation is quite often lacking west of the axis.

IV. Geological Conditions & Mining Costs.

A. Tectonics

Several factors are responsible for the rank of Alberta coals. Time of deposition is used to distinguish between coal of the Lower and Upper Cretaceous, and further between Belly River and Edmonton coal, both from the Upper Cretaceous. Such means of distinction are useful since age is an important factor in determining coal's rank or degree of maturity. Thus, other things being equal, Lower Cretaceous coal will be of a higher rank than Upper Cretaceous coal.

However tectonic conditions are often equally as important as age in determining coal rank. This is particularly

true in Alberta. For example, Belly River coal at Wainwright (see Fig. 3) is of considerably lower rank than Belly River coal laid down at the same time in the foothills on the western slopes of the Alberta Syncline. The reason is the proximity of the foothills coals to the tectonic forces responsible for the uplift of the Rockies. This importance of tectonic pressure rather than simply age in determining the rank of Alberta coals was stressed as early as 1909 by Dowling.[7]

One interesting example of the relationship between tectonics and rank occurs in the Crowsnest district (see Fig. 7). Most of the coal mined there is Lower Cretaceous from the Kootenay Formation, but there is some production two miles south of Sentinel of Upper Cretaceous coal from the Allison Formation, a local term for the Belly River Series. This Allison coal is the same age as coal twenty-four miles to the east at Lundbreck which is classed as subbituminous. Yet the Allison coal is bituminous, as is the rest of the coal of the Crowsnest Pass, and can be coked.[8] Tectonics are therefore seen to be very important influences in determining the rank and thus the physical characteristics and chemical composition of Alberta coals.

As well as having such a marked influence on the nature of the coal itself, the diastrophism associated with the Laramide

---

[7]D. B. Dowling, The Coal Fields of Manitoba, Saskatchewan, Alberta, and Eastern British Columbia, Ottawa, 1909, p. 29.

[8]B. R. MacKay, "Geology and Coal Deposits of Crowsnest Pass Area, Alberta", Summary Report, G.S.C., 1932, Part B, p. 22.

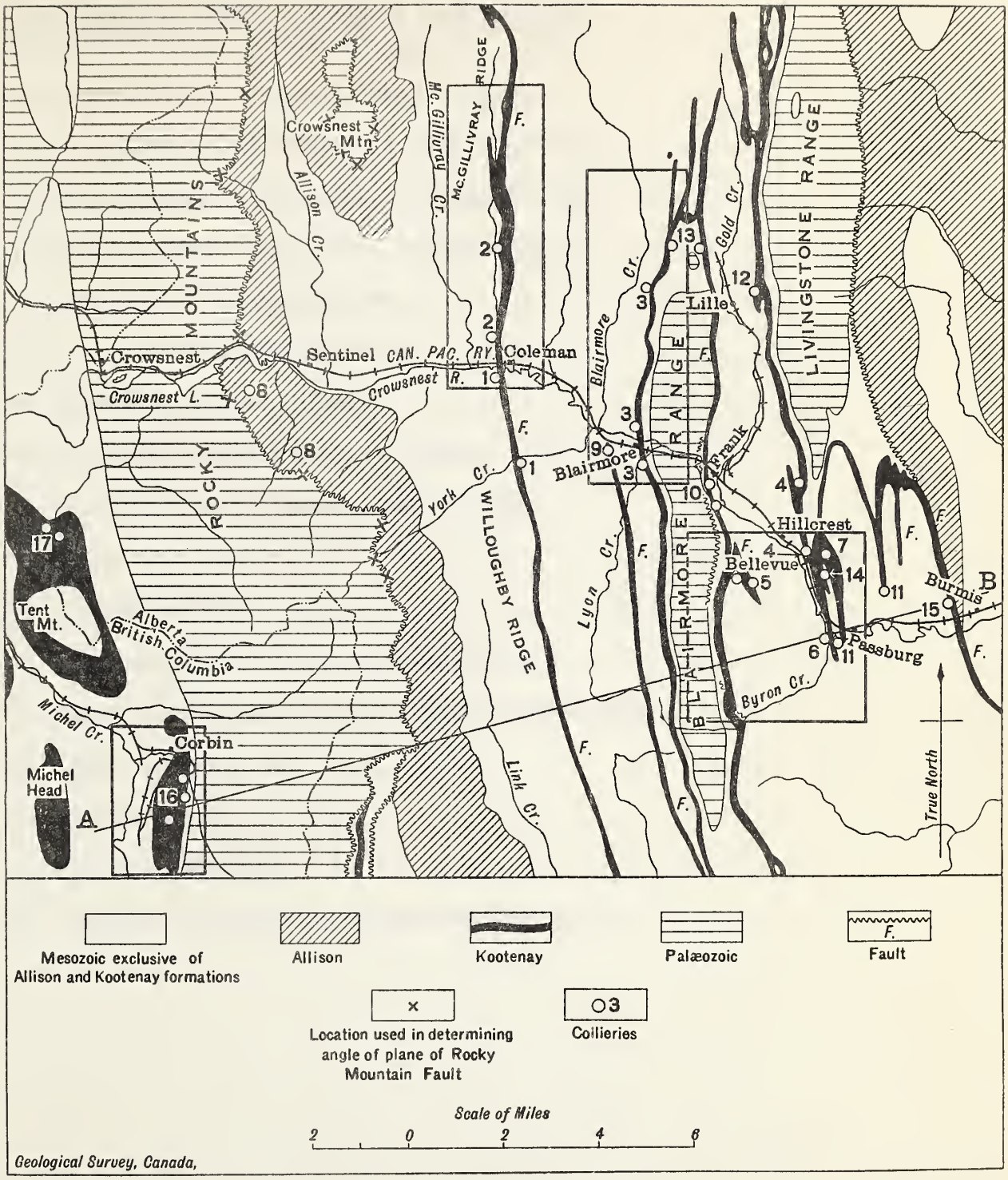


Fig. 7: Geology and Abandoned Mines, Crowsnest Pass Area.
(Source: B. R. MacKay, "Geology and Coal Deposits of Crowsnest Pass Area, Alberta", Summ. Report, G.S.C., 1932, Part B, p. 23.)

ABANDONED COAL MINES, CROWSNEST PASS DISTRICT

1. International Coal and Coke Co. Mines.
2. McGillivray Creek Coal and Coke Co. Mines.
3. West Canadian Collieries, Greenhill Mines.
4. West Canadian Collieries, Bellevue Mines.
5. Hillcrest Collieries Mines.
6. Byron Creek Collieries Mines.
7. Mohawk Bituminous Mines.
8. Canadian-American Coal Co. Mines.
9. Cartwright and Thomason Sunburst Mine.
10. Franco-Canadian Mine.
11. Leitch Collieries Mine.
12. West Canadian Collieries, Lille Mine.
13. West Canadian Collieries, Grassy Mountain Mine.
14. Maple Leaf Coal Co. Mine.
15. Burmis Mining Co. Mine.
16. Corbin Collieries.
17. Spokane and Alberta Coal and Coke Co. Mines.

Revolution also had an effect on the orientation of strata including coal seams and on the degree of concentration of coal in certain locations.

The Cenozoic mountain building forces led to great folding and faulting in the front ranges and the foothill zone. Consequently the dips of the seams of the mountain coals are often extreme. Seams in the Cadomin district generally dip at about 70° and in places the strata are overturned. In the Crowsnest, dip slopes of 20°-60° are generally present. Difficulties encountered in working such steeply pitching seams add greatly to extraction costs.

Even worse than the difficulties resulting from extreme pitch, are the pinchouts and complete discontinuities produced by the excessive faulting associated with Cenozoic orogenies. Discontinuities occur occasionally in some plains locations, such as Lethbridge, but not surprisingly they are most common in the mountain areas such as the Crowsnest and Mountain Park. Referring to the Crowsnest, B. R. MacKay wrote as follows: "In a number of areas the displacements are of such magnitude as to have caused a termination of mining operations with a great loss of invested capital which would probably have been saved had the structural conditions affecting the area been more fully appreciated."[9]

Not all the orogenic effects on Alberta's coal deposits have been disadvantageous for the mining industry. It was the

---

[9]Ibid., p. 25.

Rocky Mountain uplift which carried a good proportion of the Lower Cretaceous coal measures to the surface in the first place. Uplift, plus later erosion, particularly by Pleistocene glaciation, therefore was responsible for making these deposits accessible to the miner.

Moreover, in the highly contorted mountain areas outcrops of many different strata are abundant, and though the geology is complex, it can be worked out so that reasonably accurate estimates of reserves can be obtained. On the plains the strata are relatively flat-lying and comparatively few different formations occur at the surface. This lack of outcrops, plus the existence of glacial drift, makes it difficult to determine the extent of reserves. The problems involved have repeatedly resulted in large discrepancies in estimates of reserves in the past. It is a serious problem since without reasonably certain reserves, a mining firm is understandably hesitant about allotting capital to large expansion programs or about commencing operations in the first place. The best answer would appear to be intensive borehole programs such as those currently being carried out by the Research Council of Alberta (R.C.A.), supplemented by the records of water wells and petroleum exploration programs. Even then, the margin of error is considerable.

The diastrophism associated with the Laramide Revolution produced concentrations of coal, some of which are the largest in North America. Folding and faulting sometimes result in local thickening of seams producing deposits known as "blisters". Coal thicknesses in these blisters not infrequently exceed 100 feet as

at Tent Mountain in the Crowsnest and at the Sterco-Coal Valley deposit (see Figs. 4 & 7).

It should be recognized however that these blisters are not always the optimum deposits which they might appear to be for mining purposes. They are localized consequences of extreme folding or faulting. Many of the great thrust faults of the front ranges follow Lower Cretaceous coal seams for considerable distances. One writer has described this relationship in the following manner. "These coal seams appear to be lubricated zones along which the rock masses glided."[10] In many cases the tectonics involved in this gliding process rendered much of the coal virtually useless. The coal is so badly shattered, so crushed, that mining costs are increased considerably, partly due to the fact that extraction recovery rates are often reduced. In the past these highly friable coals posed problems with respect to both cleaning and marketing. However, techniques now used make the cleaning of fines feasible.[11] Moreover whereas the uses of fines were formerly quite restricted, today they are readily marketable in the metallurgical industries for example. Areas in which highly friable crushed coal is a common occurrence include Nordegg, Brûlé, and the Smoky River, the latter currently the center of studies aimed at development of new sources of supply for the Japanese market.

---

[10] R. T. D. Wickenden, "Coal Deposits of the Southern Rocky Mountains of Canada", Guide Book, Fourth Annual Field Conference, Alberta Society of Petroleum Geologists, Aug. 1954, p. 149.

[11] Fines are very small pieces of coal, e.g., coal which passes through a sieve of specified dimensions such as $\frac{1}{4}$ inch.

B. Other Geological Factors.

Geological conditions affect mining costs in several other ways. Prospecting and exploration programs are often costly on the plains and in the broad glacial valleys of the mountains due to the existence of a thick mantle of boulder clay and alluvium.

Another problem encountered in the highly contorted mountain seams is a high percentage of gas often under high pressure as is the case at Canmore. Plains mines have much less difficulty with gas.

The plains mines have another problem however. Coals there are generally younger than the mountain coals and have been subjected to less orogenic pressure, with the result that they are generally of lower rank. Consequently the moisture content of the plains coals is higher than that of the mountain coals. A high moisture content is indicative of high porosity which in turn contributes to more rapid weathering which adds to marketing problems since stockpiling of such coal is difficult. It is sometimes not realized, however, that this weathering also occurs in the mines themselves, once shafts bare the coal to the air. Heaving is often a consequence of this underground weathering, adding greatly to maintenance costs and reducing productivity. It also results in increased dangers in underground operations, such as those experienced at Lethbridge.

The cost of buying and installing timber for pit props and roofing has been a major item of expense in the maintenance of mines. The nature of the geological formations above and below the coal seams determines the extent of these expenses. For example the high costs of timbering due to the instability of adjacent formations contribute to the excessive mining costs in the Edmonton Coal Area.

Mine maintenance costs in the Edmonton district are also augmented by the costs of removing water from the mines. This is a problem which, though certainly not unique to Alberta mining, was commonly encountered here and was a contributing factor in the abandonment of the mines at Mountain Park in 1950, an event which signalled the beginning of the end for the Coal Branch (see Figs. 2 & 6).

Post-depositional history of a given coal deposit affects the marketability of the product. Excessive folding and faulting alter greatly the physical and chemical properties of coal. Occurrence of impurities in the coal detract from its market value. A high ash content is particularly undesirable and has been a factor in the closing of many Alberta mines including several in the Burmis district of the eastern Crowsnest. Folding and faulting can result in great variations in the properties of coals within a very small area. This is a serious problem since many types of markets demand a uniform product.

As well as adding to mining costs, several of the adverse geological conditions are a distinct hazard to underground miners.

As mining levels are pushed ever deeper below the surface, pressure increases with the result that the risk of gaseous explosions also increases greatly. The greatest hazard in Alberta's mountain mines is the "bump", which has been defined as a "violent earth tremor accompanied by disturbance of seam and/or adjoining strata."[12] Bumps are common in violently folded and faulted strata, especially at great depths where pressures are much higher. They are apparently a type of release mechanism, relieving excessive ground stresses produced by tectonic activity. Some appear to have been triggered by mining activities at great depths.

The increasing frequency of bumps with increasing depths is a major factor in the restriction of mining activity at Canmore to depths of 2,000 feet or less[13]. It was also one reason why MacKay, in his study of Canada's coal reserves, restricted recoverable coal to that occurring less than 2,500 feet below the surface[14]. Should the research of the Fuels Division of the Department of Mines and Technical Surveys and other bodies into the causes and prevention of bumps prove successful, the results would be very significant. "The future of the coal mining industry, in our mountainous regions at least, depends on ability to extend operations successfully to

---

[12]H. E. Miard, "Sudden Release of Ground Stresses in the Coal Mines of Western Canada", Transactions of the Canadian Institute of Mining and Metallurgy, vol. 56, 1953, p. 219.

[13]W. J. Riva, "Metallurgical Coke from High-Carbon Coals", Western Miner, vol. 36, no. 4, April, 1963, p. 29.

[14]A. Brown, T. S. Cochrane, and T. H. Patching, "Ground Stress Studies in Coal Mines of Western Canada--A Progress Report", Transactions of the Canadian Institute of Mining and Metallurgy, vol. 61, 1958, p. 364.

depths greater than those reached now."[15] The ability to minimize the dangers and maintenance costs resulting from bumps would be very beneficial to the mining industry. Bumps have even been partially responsible in the past for the abandonment of major mines such as Frank in the Crowsnest in 1919 and Cadomin on the Coal Branch in 1952.

V. Classification of Alberta Coals.

Because properties of coal vary so greatly, some system of classification is desirable if not necessary in order to permit marketing of a reasonably standardized product and also to facilitate research into the properties and utilization of coal. A classification system also eases the task of the provincial government in its inspection of mines and compilation of production statistics. Despite these obvious advantages, it has been difficult to agree upon a classification system. The following table indicates the system used by the Alberta Department of Mines and Minerals (see Table I).

Even though the situation is still somewhat confused with respect to a classification system for coal, it is enough to recognize that classification is possible and useful due to coal's varying composition. Coal consists principally of fixed carbon, hydrogen, and oxygen but it is also characterized for practical purposes by proximate analysis which measures such quantities as the proportion of moisture, volatile matter, and ash. By definition, 100 - (ash + volatile matter + moisture content) = fixed carbon. The latter can be used as a basis for determining rank as shown in Table II.

---

[15]Miard, op. cit., p. 219.

TABLE I

CLASSIFICATION OF ALBERTA COAL

Group Divisions Used in Alberta	Rank of Coal		Classification Used by Mines Branch
	anthracite		anthracite
I	semi-anthracite		
	low volatile bituminous		
	medium volatile bituminous		bituminous
II	high volatile bituminous	A	
	high volatile bituminous	B	
III	high volatile bituminous	C	
	sub bituminous	A	sub-bituminous
IV	sub bituminous	B	
	sub bituminous	C	
V	lignite		

The letters "A", "B", and "C", refer to calorific values.

For high volatile bituminous
- A - more than 14,000 B.T.U. per pound
- B - 13,000 to 14,000 B.T.U. per pound
- C - 10,500 to 13,000 B.T.U. per pound (agglomerating)

For sub-bituminous
- A - 10,500 - 11,500 B.T.U. per pound (non-agglomerating)
- B - 9,500 to 10,500 B.T.U. per pound
- C - 8,300 to 9,500 B.T.U. per pound

TABLE II[16]

CARBON CONTENT OF COAL

	fixed carbon
anthracite	80%
semi-anthracite	75-85
bituminous	65-75
sub-bituminous	about 50-60
lignite	as low as 40

[16]H. L. Draper, The Alberta Coal Problem, Montreal, 1930, p. 19.

Alberta has reserves of all ranks of coal ranging from lignite in some parts of the Edmonton Formation to semi-anthracite of the Kootenay Formation. However there is no true anthracite in the province, and reserves of lignite are very small, being restricted to the Pakowki Coal Area, and are not commercially exploited.

It might be useful to comment upon a misconception widely held among laymen to the effect that high rank coals are necessarily better for all purposes than are low rank coals. This idea is completely false. Rank refers only to percentage of carbon and does not in any way refer to utility of coal. In actual fact anthracite's exceedingly high percentage of carbon makes it unsuitable for use in many markets. For many non-fuel uses of coal, the lower ranks are definitely preferred. This is particularly true in the promising new field of carbo-chemical fertilizers. The low to medium rank coals are also suited for use as sources of synthetic fuels and gases.

VI. Properties of Coal in Relation to Specific Uses.

The only measure of utility with which rank can be directly correlated is that of heat value or calorific value. Generally the Lower Cretaceous coals of the mountains have considerably higher calorific values than do the lower rank plains coals. Canmore coal has a calorific value of 13,500 to 14,000 B.T.U. per pound, the highest in Alberta and as high as any in Canada. Most of the other mountain coals have similarly high calorific values, usually in excess of 12,500 B.T.U. That of Nordegg, for instance, is nearly 13,000. Eastward from the mountain front and the center

of orogenic activity occur coals of lower calorific value such as those at Sterco and Coal Valley which are about 11,200 B.T.U. per pound.

Lethbridge, historically the leading producer of Belly River coal, mines a coal with a heat value of about 10,680 B.T.U. per pound. This is higher than the average for Belly River coal due to the proximity of Lethbridge to the center of orogenic activity.

The calorific value of coals from the two historically important districts of the Edmonton Formation, Drumheller and Edmonton, is relatively low, being about 8,725 B.T.U. per pound. A leading producer in this formation today, Battle River, also mines a coal of low heat value, ranging from 8,500 to 8,800 B.T.U.

One of the most important indices with respect to the marketability of Alberta coal until very recently has been its resistance to weathering. Basically weathering is the process of oxidation. It occurs in coal that is exposed to the atmosphere, either in outcrops or in storage stockpiles. Oxidation is most rapid in low rank coals. Because of their higher content of moisture and volatile matter, they are more prone to disintegration or slacking when exposed to the elements. Slacking in turn, by producing a greater surface area, encourages more oxidation.

Weathering is undesirable because it reduces coal's heating value, its coking properties, its average particle size, and its capacity for gas production. Moreover, by increasing the

surface area of the coal, it increases the danger of spontaneous combustion.

Being relatively high in rank, Alberta's bituminous coals weather very little in storage, even without protection from the elements. The situation is much different with respect to the lower rank sub-bituminous coals of the plains. Admittedly there are exceptions such as in the Lethbridge and Magrath districts where proximity to the Rockies is responsible for a coal that is harder and more weather-resistant. However in most mining districts of the plains, inability of the coal to resist weathering has long been an obstacle to large scale exploitation of the coal deposits. This is particularly true of Edmonton and Drumheller. Speaking on Canada's coal policy, George Prudham, Federal Minister of Mines and Technical Surveys, said in 1953, "Many types of western coal cannot be stockpiled and therefore are restricted largely to the local market."[17] This statement unfortunately applies very well to Drumheller which at various times in the past made concerted efforts to capture the household fuel market in Ontario. Because it could not be stockpiled, Drumheller coal had to be transported east during the autumn to meet winter fuel demands. Unfortunately this movement of coal coincided with the grain shipping season when rolling stock was in short supply. Had storage been practicable, the coal could have been railed east in smaller, steadier quantities throughout the year when railroad cars were more readily available. Such

---

[17]George Prudham, "Canada's Coal Policy", Western Miner, vol. 26, no. 8, August, 1953, p. 40.

a market would have alleviated considerably the seasonal fluctuation which plagued the plains mines, since more sales would have been maintained during the summer.

The best means of reducing weathering involves protection of the coal from the elements. Since lump coal is less susceptible to weathering than fine coal due to its lesser surface area, it follows that coal which has been crushed and then well-compacted might be expected to store well. On this basis sub-bituminous coal with a high moisture content can be stored outside, as at the Battle River power station.

Because particle size is so important in resisting weathering, a highly friable coal is distinctly undesirable. "Friability of a coal is its tendency to degrade in size when subjected to handling."[18] "Handling" refers especially to rail transport. Unfortunately, many Alberta coals are highly friable. This applies to mountain coals such as those of Brûlé and the Smoky River where extreme mountain-building forces in many cases crushed the coal. It also applies to the coal of the Edmonton Formation which was so far from the center of orogeny that the compressive forces were negligible. Among the least friable coals in the province are those of Lethbridge. This region was apparently close enough to the orogeny to receive significant compressive forces, yet

---

[18] American Coal Sales Association, Handbook for Coal Salesmen, Washington, 1951, p. C-7.

far enough removed to escape the excessive crushing which occurred in some of the seams of the front ranges. The result is a fairly hard coal which is quite weather-resistant.

Impurities detract from the market value of Alberta coal. Ash, the non-combustible residue left after burning, is undesirable dead-weight. For closely similar coals the calorific value will be inversely proportional to the ash content. Not a few Alberta mines have been abandoned because a high ash content made it difficult to market the product. This was the case with several mines in the eastern Crowsnest in the period 1915-22.

In Alberta, coking coals tend to have calorific values in the range of 12,500-14,000 B.T.U. per pound and moisture contents of less than three per cent. However heat value and moisture content are irrelevant with respect to coking. Alberta's best coking coals are the medium and high volatile bituminous coals of the Lower Cretaceous, located in the front ranges of the Rockies from the Crowsnest to the Smoky River. None of the coals in the Edmonton or Belly River Formations are suitable for coking purposes.

Gasification of coal has not been carried out in Alberta to any great extent, due largely to the existence of interfuel competition from natural gas.

One application of coal which has recently become highly significant in Alberta involves combustion of the coal in pulverized form. Such combustion is complete and easily controlled. Coal for this purpos

should have a low moisture content, preferably less than six per cent. Thermal power operations at Wabamum and Battle River reflect the importance in Alberta today of the use of pulverized coal.

VII. Alberta Coal Reserves.

In some ways, a discussion of reserves is admittedly academic and of marginal value. The following statement appears in one of the works in the American series, Resources for the Future:

> The conclusion on coal availability differs . . . from those on the availability of other energy sources in that there is no attempt to quantify the availability. Quantification is not considered necessary . . . since there is clearly enormous unutilized potential productive capacity on the basis of known resource data. There is . . . no indication of resource limitation on present capacity or on any future capacity level that might be required in 1975.[19]

This statement made with reference to the coal industry of the United States applies equally well to Alberta. Moreover a discussion of reserves becomes even more questionable when one considers the rapidity of technological change in our society and the consequent effects on the means of both the extraction and utilization of coal. In addition, methods of evaluation are constantly under revision, with the result that estimates of reserves are almost transitory in nature. To speak in terms of 2,000 year reserves with respect to an industry whose terms of reference have changed radically even with the past two decades, would appear to be virtually meaningless.

---

[19] S. H. Schurr and B. C. Netschert, Energy in the American Economy, 1850-1875, Baltimore, 1960, p. 343.

Yet in spite of all these conditions, there is something to be gained from a discussion of Alberta's reserves. Firstly it is interesting to note the differences in the evaluation of the province's reserves during the past fifty years. Such a review emphasizes the importance of one's terms of reference in determining reserves. Secondly, although the numerical values attached to reserves of different areas may be of little significance in themselves, it is important to know where the largest reserves occur, i.e., to have some impression of the relative size of the reserves of different areas. Thirdly, despite the somewhat academic nature of the question and the difficulties involved in determining an accurate estimate of reserves, the question is a vitally important one for any single commercial undertaking. Coal mining in Alberta today is becoming an extremely large scale operation. Hence before any new development is begun, a reserve must be proven which is large enough to justify the initial capital outlay. Both the importance and the difficulty of establishing the existence of such a reserve and the feasibility of working it have been evident in the recent controversy over large scale development of the Ardley field.

The first detailed studies into coal reserves on a province-wide basis were carried out by D. B. Dowling and presented in a report to the Twelfth International Geological Congress in 1913. Alberta's reserves were given as shown in Table III. When these figures were published by the Federal Department of Mines in 1915, many Canadians believed that their country contained the world's most valuable coal reserves. Too few of them examined closely

TABLE III[20]

DOWLING'S ESTIMATE OF ALBERTA COAL RESERVES

	Alberta coal reserves		
	in billions of tons	as % of Canada's reserves	as % of world reserves
Anthracite	0.8	35.6	0.2
Bituminous	198.1	69.8	4.1
Sub-bituminous and lignite	876.2	92.4	29.2
Total	1,075.0	87.1	14.5

[20]Alberta, Report of the Royal Commission on Coal, 1925, Edmonton, 1926, p. 32.

Dowling's terms of reference. He had not overly concerned himself with the economic feasibility of recovering coal but merely with its existence. Hence he gave little consideration to geologic structures which would seriously hamper extraction of deposits and continued to include these deposits in his totals. Moreover his inclusion of one foot seams to a depth of 4,000 feet meant that he was including millions of tons of coal which it was highly unlikely could ever be mined economically. At the time he was compiling his statistics, no Alberta seam as thin as one foot had been mined to a depth as great as 500 feet, much less 4,000. In addition Dowling included reserves in deposits which had already been worked but abandoned. He did not take into account the many factors which can render an abandoned mine virtually useless economically. The quality of the coal often deteriorates due to more rapid weathering. Moreover costly new ventilation systems and roofing are almost always necessary. Finally, as more knowledge of Alberta's geology began to accumulate over the years, it was found that coal was lacking in many locations which Dowling had noted as containing large reserves.

What is seldom realized is that Dowling was well aware of the limitations of his studies. He never intended that his estimates be regarded as definitive, but merely as upper limits.[21] They proved to be much more accurate in the mountains where outcrop

---

[21]Dowling, op. cit., p. 11.

patterns were much more readily discernible than on the plains (see above, p. 13). In fact the exploration program recently undertaken by the Research Council of Alberta, estimating reserves on the basis of a large number of boreholes, is providing the first authoritative estimate of reserves in much of the plains area.

After Dowling, the next important study concerning the size of Alberta's coal deposits was that carried out in 1925 by Dr. John Allan of the University of Alberta's Department of Geology. Allan submitted his findings to the 1925 provincial Royal Commission on Coal. Allan estimated Alberta's reserves as follows:

bituminous	31.4 billion tons
sub-bituminous	14.6 billion tons
lignite	11.5 billion tons
Total	57.5 billion tons

Thus Allan's total was only 5.3% of that of Dowling. The difference is partly due to the terms of reference used. Whereas Dowling included one foot seams to depths of 4,000 feet, Allan included only two foot seams to depths of 1,000 feet.[22]

In 1935, another provincial Royal Commission on Coal was called. Again Allan contributed findings on reserves. Studies in the interim period led him to revise his findings of 1925. The area within the province underlain by coal was taken as 1,717 square miles, about two per cent of the figure used by Dowling. Also he

---

[22]Alberta, Report of the Royal Commission on Coal, 1925, Edmonton, 1926, pp. 32-35.

he now excluded all seams less than three feet thick. He concluded that Alberta's reserves amounted to 40 billion tons.

Allan made yet another estimate on reserves in 1945, this one for the Alberta submission to the Federal Royal Commission on Coal headed by W. F. Carroll. Allan's 1945 figure of 46.6 billion tons was slightly higher than that of 1935. His terms of reference were unchanged, the increase in reserves being due to new geological knowledge gleaned over the ten year period.

The figures now most widely used with respect to Alberta's reserves are those arrived at by B. R. MacKay of the Geological Survey of Canada (see Fig. 8). His findings were included in the Report of the Carroll Commission.[23] Though MacKay's terms of reference differed somewhat from those used by Allan in 1935 and 1945, his final conclusion is very close to Allan's 1945 figure. MacKay included all coal in seams at least three feet thick. For bituminous deposits, he included seams to a depth of 2,500 feet, but for sub-bituminous deposits he concurred with Allan's 1,000 foot limit. Using these criteria MacKay arrived at the totals shown in Table IV.

MacKay thus estimated that Alberta had 48.5 per cent of Canada's total reserves, whereas Dowling had concluded that this province had 87 per cent of the country's total. In turn Canada's reserves are now placed at about 1.8 per cent of those of the entire world compared with Dowling's figure of 16.7 per cent.[24]

---

[23]Canada, Report of the Royal Commission on Coal, 1946, Ottawa, 1947, pp. 1-59.

[24]M. R. Hubbert, Energy Resources, Washington, 1962, p. 37.

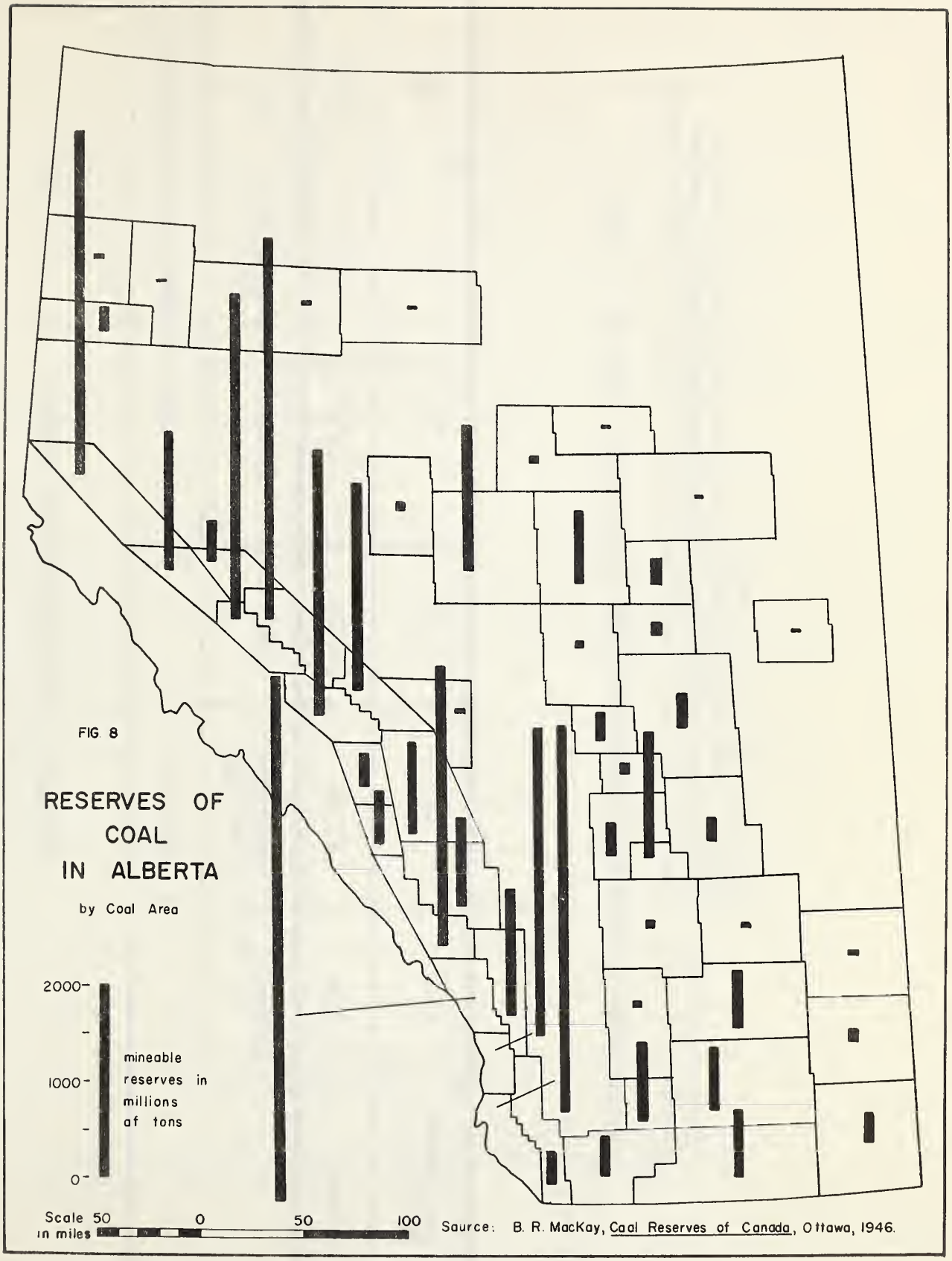


FIG. 8
RESERVES OF COAL IN ALBERTA
by Coal Area
2000
1000
0
mineable reserves in millions of tons
Scale 50 in miles
0
50
100
Source: B. R. MacKay, Coal Reserves of Canada, Ottawa, 1946.

TABLE IV

RESERVES OF COAL IN MILLIONS OF TONS[25]

	Mineable			Recoverable (assuming a 50% recovery rate)		
	Probable[26]	Possible[26] (additional)	Total	Probable	Possible (additional)	Total
Alberta	34,438	13,436	47,874	17,219	6,718	23,937
Alberta as a % of Canada	54.8	35.1	48.5	54.8	35.1	48.5

[25]Canada, Report of the Royal Commission on Coal, 1946, Ottawa, 1947, pp. 11 & 603

[26]Probable reserves: Known through direct mining experience or intensive geological studies.
Possible reserves: Existence known only through limited geological studies. Moreover recovery is questionable owing to marginal quality of the coal or inaccessibility of the location.

However despite the fact that studies by Allan and MacKay are now widely known and accepted, the original figures published by Dowling have often been quoted since 1925 when Allan's first revision appeared. The geographer Stephen B. Jones wrote in 1933 that, "Alberta contains one-seventh of the world's coal and nine-tenths of Canada's. . . ."[27] And as recently as 1954, J. Visman of the Research Committee of the Coal Division, Department of Mines and Technical Surveys, gave the reserves of B.C., Alberta, and Saskatchewan as one-sixth of those of the world.[28]

These statements were based on Dowling's estimates of 1913. The continued use of these figures, long since superseded, is unfortunate, especially by such prominent individuals. It gives rise to a great deal of confusion concerning the size of the reserves of Alberta and Canada, and is responsible for a fairly widespread opinion among Canadians that their coal reserves are among the largest in the world. There is a considerable difference between Dowling's estimate that Canada possessed 16 per cent of world reserves and the currently accepted figure of 1.8 per cent.

Yet despite the fact that MacKay's estimates involve considerable reductions from those arrived at early in this century,

---

[27]S. B. Jones, "Mining and Tourist Towns in the Canadian Rockies", Economic Geography, vol. 9, 1933, p. 372.

[28]J. Visman, "The Status of Coal Cleaning in Western Canada", Transactions of the Canadian Institute of Mining and Metallurgy, vol. 57, 1954, p. 13.

they are still impressive. Production of coal from these reserves has played an important part in Alberta's economic history and in the development of certain economic regions within the province. These topics will be discussed below.

CHAPTER II

RAILROADS AND COAL

The history of Alberta's coal industry has been marked by a high degree of interdependence with the railroads. Coal is a high bulk, low value commodity and is unable to withstand high transport costs to the same degree as gold and uranium. Coal must move by bulk transport which in the past has meant transport either by water or rail. If new deposits are discovered in an area which is not served by either means, the reserve must be great enough to warrant expenditures for the installation of transport facilities.

Given Alberta's drainage patterns, precipitation regimen, and severe winters, large-scale water transport is impractical. Thus before the coal industry of Alberta could become an important economic activity, rail access was necessary. Admittedly coal mining predated the coming of the railroad in many areas, but it was always on a small scale and almost always oriented to marketing over a very restricted area. Access to railroads greatly extended the market area for Alberta coal mines, and for the bituminous mines, the steam locomotives themselves provided a major market.

The great period of railroad construction in Alberta, roughly from 1885 to 1920, had two general effects on the location of coal mines in Alberta. In those areas where mining was already being carried on, the arrival of the railroad resulted in a concentration of production near the transport facilities. Inadequte and costly means of transport favor local inefficient producers of

poor coal. Once adequate transport is available, production tends to become concentrated where optimum conditions prevail, with many of the small inefficient operations, without ready access to the railroad, being abandoned.

I. The Effect of Railroads on the Establishment of Coal Mining on the Plains.

A. Edmonton.

This process of economic centralization occurred for example in three of the early leading producing areas of the plains--Edmonton, Drumheller, and Lethbridge. Frank B. Smith wrote as follows concerning coal mining in the Edmonton district in 1903.

> Already there are about thirty independent operators within a radius of twenty miles, each of them producing from three to thirty tons per day. The coal is lignitic in nature--very suitable for domestic purposes and stationary boilers. The great stir in railway circles is no doubt the cause of all this activity, and as soon as a transcontinental road penetrates the country, these numerous small mines will be closed down and coal mining will be carried on more extensively by two or three companies operating large areas.[1]

Smith's predictions were substantiated when the two railroads reached Edmonton within seven years. These were the Canadian Pacific Railway from Calgary in 1903 and the Grand Trunk Pacific Railway from the east in 1909. As a result, the coal mines of the Edmonton district which had been local enterprises, were re-oriented to serve the household fuel needs of the entire plains region of western Canada. Dowling attached a great deal of

---

[1] Frank B. Smith, "Mining in the North-West, 1902", Journal of the Canadian Mining Institute, vol. 6, 1903, p. 374.

importance to this development. He wrote in 1909 that the construction of the railroads to the Saskatchewan plains was not in itself enough to populate them. Only after the railroad penetrated the Alberta coal producing areas, could the plains be a really attractive immigration target, since the railroads facilitated movement of coal, a vital fuel in an almost treeless region.[2]

B. Drumheller.

Rail facilities also played a key role in expansion of mining in the Drumheller district. The first mine was that of Jesse Gouge who began operations in 1911 at what later came to be known as the Newcastle Mine. Gouge shipped to Calgary via Vegreville, there being no direct rail link between Calgary and Drumheller. The necessary line was completed in 1913 by the C.P.R. This provided an immediate stimulus for further mining development. The Red Deer Valley Coal Company opened a mine about five miles west of Drumheller near the mouth of Kneehills Creek, on the south (right) bank of the Red Deer River (see Fig. 9).

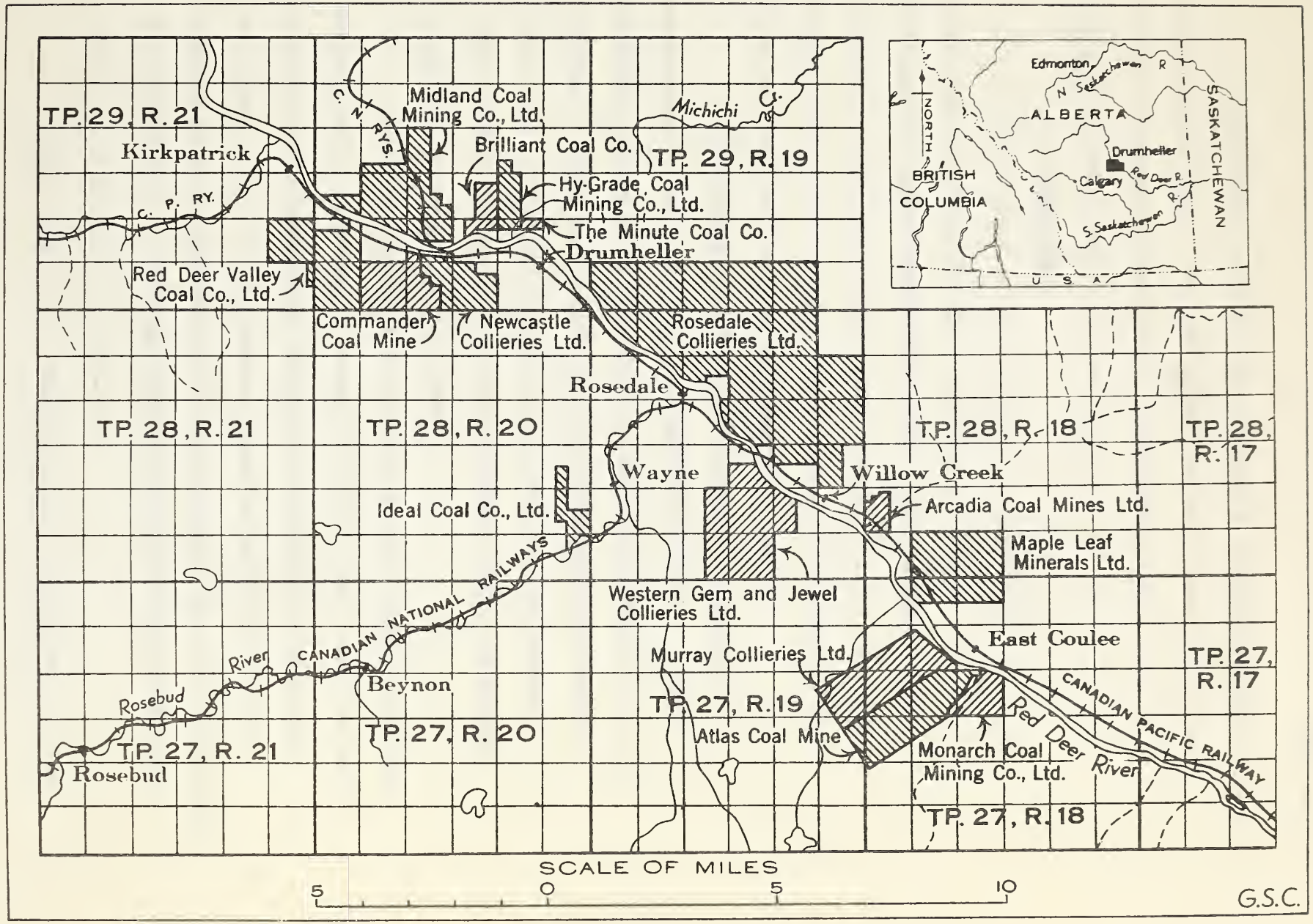
The new railway line also prompted Rosedale Collieries on the north bank of the Red Deer River to build an aerial tramway across the river where a tipple was erected. Production continued on this basis for seventeen years, averaging 250 tons per day. Then in 1930 railroad access to the north bank was provided. Immediately a new preparation plant was built and capacity increased to 600 tons per day.

---

[2]D. B. Dowling, The Coal Fields of Manitoba, Saskatchewan, Alberta, and Eastern British Columbia, Ottawa, 1909, pp. 18-19.

Fig. 9: Drumheller Coal Area.

Source: Canada, Royal Commission on Coal (1959), Submission by The Drumheller Coal Operators' Association



Today the railroad continues to be an important part of mining in this area. The sole major mine still operating in the district ships eighty per cent of its output by rail. This is Amalgamated Coals Limited of East Coulee.[3]

C. Lethbridge.

The history of coal mining in the Lethbridge district similarly involves small scale operations in the pre-railroad era followed by a great expansion of markets when rail access was provided. Lethbridge is interesting because this is the only mining center where the alternative form of bulk transport was given an extensive trial and subsequently rejected.

Mining began in 1874 when Nicholas Sheran opened his operations at Coal Banks (later renamed Lethbridge). This is generally considered to have been the first commercial mine in the province. Sheran hauled coal by team to the Northwest Mounted Police post at Fort Macleod and even to Fort Benton, Montana. Large scale operations did not begin, however, until the arrival of the Galt family and the railroad.

Sir Alexander Galt and his son Elliott founded the North-western Coal and Navigation Company in 1882. Their intention was to mine coal at Lethbridge and transport it 110 miles by barge down the Oldman and South Saskatchewan Rivers to Medicine Hat where Canada's first transcontinental railroad crossed the South Saskatchewan River (see Fig. 4). Only two hundred tons were shipped during the

---

[3]Pers. Comm., A. C. Hnatyshyn, East Coulee, Aug. 5, 1965

first barging season. The highly variable flow of the two rivers made the shipping season exceptionally short. Thus, although one steamer did manage to barge four thousand tons of coal in 1884 in a season of little more than one month, it was recognized that given the irregular flow régimes of Alberta streams, river transport was impractical.

Having rejected water transport, the Northwestern Coal and Navigation Company turned to railroads. In 1885 construction was completed on the narrow gauge Galt Line from Medicine Hat on the C.P.R. to Lethbridge. The steamers and coal barges were thus superseded after only three brief seasons.

Now having adequate access to a large market area via the Galt Line and the C.P.R., the Lethbridge mines grew rapidly. In 1889 the Alberta Railway and Coal Company was formed, and it absorbed the Northwestern Coal and Navigation Company. Eventually in 1911, the former company and two other firms, including one other railway, were all taken over by the C.P.R. and integrated with its Crowsnest Pass Branch. The C.P.R. continued to operate the two largest mines in the Lethbridge district for many years. However by 1911 the C.P.R. no longer used Lethbridge coal in its steam locomotives. With the rapid development of the deposits of high rank steam coals of the Crowsnest about the turn of the century, Lethbridge, which for nearly twenty years had been the C.P.R.'s chief source of fuel, re-oriented its industry to serve the domestic market via the growing rail net.

II. The Effect of Railroads on Coal Mining in the Mountains.

A. Transcontinental Routes.

The railroads' effect on coal mining in the mountains was considerably different. On the plains they had contributed to some rationalization and centralization of mining, and had enabled the operators to sell in a regional market rather than a local one. In the mountains, however, there was only a very small population, and the local market was thus almost non-existent. Therefore, coal mining was almost non-existent. Here the coming of the railroads meant not the re-orientation of an old industry but stimulation of an entirely new one. Wherever the transcontinental lines intersected the Lower Cretaceous coal measures on the eastern slopes, mines and mining communities sprang up (see Figs. 2 & 6). Canmore, Anthracite, and Bankhead appeared on the mainline of the C.P.R. Coleman, Blairmore, Frank, and many other smaller settlements developed along the Crowsnest Pass Branch, after its completion in 1878. Farther north, Brûlé and Pocohontas were established in the Athabaska Valley on the route of the G.T.P.R. and Canadian Northern in the period 1908-1913. There is then a definite correlation between the location of the railroads and the bituminous mines.

Thus most of the coal mining centers of the mountains were born as a result of the construction of the railroads. Moreover for nearly half a century they owed their continuing existence to the railroads. The latter not only provided them with access to markets; the steam locomotives themselves provided the major market

for every Alberta bituminous mine at its inception. In some cases mining centers sold as much as ninety per cent of their output for locomotive fuel. Thus in the mountain areas, coal mining development ". . . is in large part a consequence of railway development . . . [and] has depended largely on the fluctuating fuel requirements of the railways, with only relatively small industrial sales demand."[4]

Hence coal mining in western Canada has not been intimately associated with integrated industrial growth as in the northeastern United States and in western Europe. Therefore it has not exhibited steady growth along with population and the economy as a whole. Instead of being a basic foundation of the economy, coal mining in Alberta has in many cases been ". . . merely an offshoot of agricultural and railway expansion."[5]

B. The Position of Railroads in Studies of the Geological Survey of Canada.

The importance of the railroads to coal mining was recognized very early. In his 1919 report on the Smoky River coal deposits, John MacVicar of the Geological Survey of Canada (G.S.C.) wrote that, "The great resources in coal of this and the adjoining regions can be made available only by the construction of a railway . . . ."[6]

---

[4]F. W. Gray, "Canada and Coal", The Canadian Mining and Metallurgical Bulletin, vol. 37, 1944, p. 53.

[5]Loc. cit.

[6]John MacVicar, "Coal Areas Northwest of Brûlé Lake, Alberta", Summary Report of the G.S.C., 1919, Part C, p. 8.

Recognition of this circumstance meant that whenever a party from the G.S.C. went into an area in those days, its aims were twofold:

1) to determine the extent of the mineral resources.

2) to determine the practicability of building a railway to these resources.[7]

The reports of Dowling, who carried out such extensive studies on Alberta's coal deposits in the early part of the century, contain many references to possible rail routes. In his 1908 report on the lower Kananaskis district (now Cascade Coal Area) he wrote that,

> On the slope to the Bow River, a stream, heading in in a cirque north of Wind mountain, gives a workable grade down to the large open valley eroded out to the limestone range and making an excellent site for a colliery . . . . On the Kananaskis side the valley of this stream is wide close to where the coal measures cross it, hence there is ample room and an excellent site for a town.[8]

Thus studies of the G.S.C. were not concerned simply with geological occurrence but with accessibility by railroad and with site possibilities for development.

In 1910 the G.T.P.R. advanced to within eighty miles of the Rockies, stimulating great activity in coal prospecting and development along the proposed route. Dowling investigated coal deposits in this area, discovering the Scovil Creek deposits about two miles west of Brûlé Lake. He reported that "The localities of the coal outcrops are very advantageously situated both for mining and shipment . . . . Small mining towns are sure to grow up within the

---

[7] Idem, "Preliminary Investigations of Coal Deposits on Smoky, Hay, and Berland Rivers, Alberta", Summary Report, G.S.C., 1923, Part B, p. 21.

[8] D. B. Dowling, "Steam Coals of the Cascade Basin. Lignite Areas of Alberta and Saskatchewan. Production of Coal in Alberta and Saskatchewan." Summary Report of the G.S.C., 1908, p. 79.

[Jasper park]."[9] His prediction proved to be correct, for this was the site of Pocahontas (see Fig. 4).

Even in the post World War II period, the location of railroads has continued to influence the exploratory work of the Research Council of Alberta. Clow and Crawford in their 1951 study in the Carbondale River area southwest of Pincher Creek wrote that ". . . it was considered that detailed geological surveys, having as a principal objective the exploration of coal seams, should be restricted to unmapped areas within easy reach of railways."[10] Earlier one of the factors which had led John Allan in 1947 to downgrade the deposits of the Highwood-Elbow district was the extreme difficulty of railroad construction into the area.[11]

C. The Coal Branch and Nordegg.

As well as the bituminous coal mining centers which arose where the three transmontane railroad lines intersected the Lower Cretaceous coal measures, two other important bituminous mining districts were established immediately prior to World War I. Though not located on the direct routes heading for the Kicking Horse, Crowsnest, and Yellowhead Passes, these two areas were deemed to have sufficiently large reserves of steam coal to warrant development.

One was the region southwest of Edson which has come to be known as the Coal Branch. The deposits in this area were dealt with

---

[9] Idem, Coal Fields of Jasper Park Alberta", Summary Report of the G.S.C., 1910, p. 154.

[10] W. H. A. Clow and M. B. B. Crockford, Geology of Carbondale River Area, Alberta, Edmonton, 1951, p. 10.

[11] J. A. Allan and J. L. Carr, Geology of Highwood-Elbow Area, Alberta, Edmonton, 1947, p. 63.

by Dowling in the G.S.C. report of 1909.[12] Construction of the G.T.P.R. stimulated mining development not only along the route itself at such points as Pocahontas, but also in the coal rich area to the south. A railroad was completed to Mountain Park in 1911 and the line from Coalspur to Lovett in the following year facilitated development of the eastern arm of the Coal Branch.

The second major bituminous mining center to be established off the three main rail routes was Nordegg. The nearby Bighorn Basin coal deposits were discovered by Dowling in 1906 and as they were then the farthest north of the known reserves of steam coal, they were of great interest to the G.T.P.R. and later to the Canadian Northern which also was routed through the Yellowhead Pass. Eventually members of the original German syndicate which initiated development of the Nordegg area joined with the Canadian Northern to form Brazeau Collieries Limited. This firm's aims were to develop the coalfield and to link it by rail with the Canadian Northern at Stettler. The 178 mile transport connection was completed in 1913 and by 1915 Brazeau Collieries was Alberta's second largest coal producer. Other mining centers, Alexo and Saunders, also grew up 20-25 miles east of Nordegg on the Brazeau Branch (see Fig. 12).

There is a fundamental difference between the establishment of the bituminous coal mines on the main transcontinental rail routes on the one hand, and those on the Coal Branch and Brazeau Branch on

---

[12] D. B. Dowling, "Coal Fields South of the Grand Trunk Pacific Railway, in the Foothills of the Rocky Mountains, Alberta", Summary Report of the G.S.C., 1909, pp. 139-150.

the other. In the former case the railroads were built for other purposes, and stimulated development of coal deposits which they intersected. However the Coal Branch line and the Brazeau Branch line were both constructed specifically to provide access to coal reserves.

D. The Crowsnest Pass

The case of the Crowsnest Pass Railway is less clear-cut. Unlike the Coal Branch and Brazeau Branch, it is a through route. Yet the Crowsnest line was not intended to serve as a transcontinental line like those through the Yellowhead and Kickinghorse Passes. The railroad was built originally to service the metallurgical industry of the Kootenays. Upon completion in 1898 of the line between Lethbridge and the south end of Kootenay Lake, coal and coke from the Crowsnest were railed to the lake terminus, then transhipped to barges, and lightered to Nelson with no break-of-bulk. The railway was not extended through the Kettle Valley, and thus to the Pacific until just prior to World War I.

Three parties figured in the construction of the Crowsnest Pass Railway. Foremost, obviously, was the C.P.R. Second was the Crow's Nest Pass Coal Company, formed in Fernie in 1897. This firm contracted to ship coal and coke via the C.P.R. and thus justify the costs of construction. Finally there was the federal government which subsidized construction to the extent of $11,000 per mile. This was done on the understanding that the C.P.R. would set relatively low freight rates on the new line, thus enabling it to serve as an

aid to regional development. Pressure from two other sources also hastened construction of the line. The British Columbia government feared that unless it were built the mineral rich East Kootenays would become closely tied economically to the United States via American railroads such as the Great Northern. Others interested in construction of the line were the ranchers of the southern Alberta foothills desiring access to new markets.

In some cases the desire to stimulate regional development is still the main raison d'etre for new railraods. Even if the installation of transport facilities is not justified on the basis of the coal reserves themselves, the facilities are often deemed warranted for the exploitation of other resources, for the opening up of new regions, or for military purposes. This aspect of general regional development, as well as provision of access to coal deposits, is the justification given for the projected railroad linking Hinton and Grande Prairie via the Smoky River coalfield (see Fig. 10).

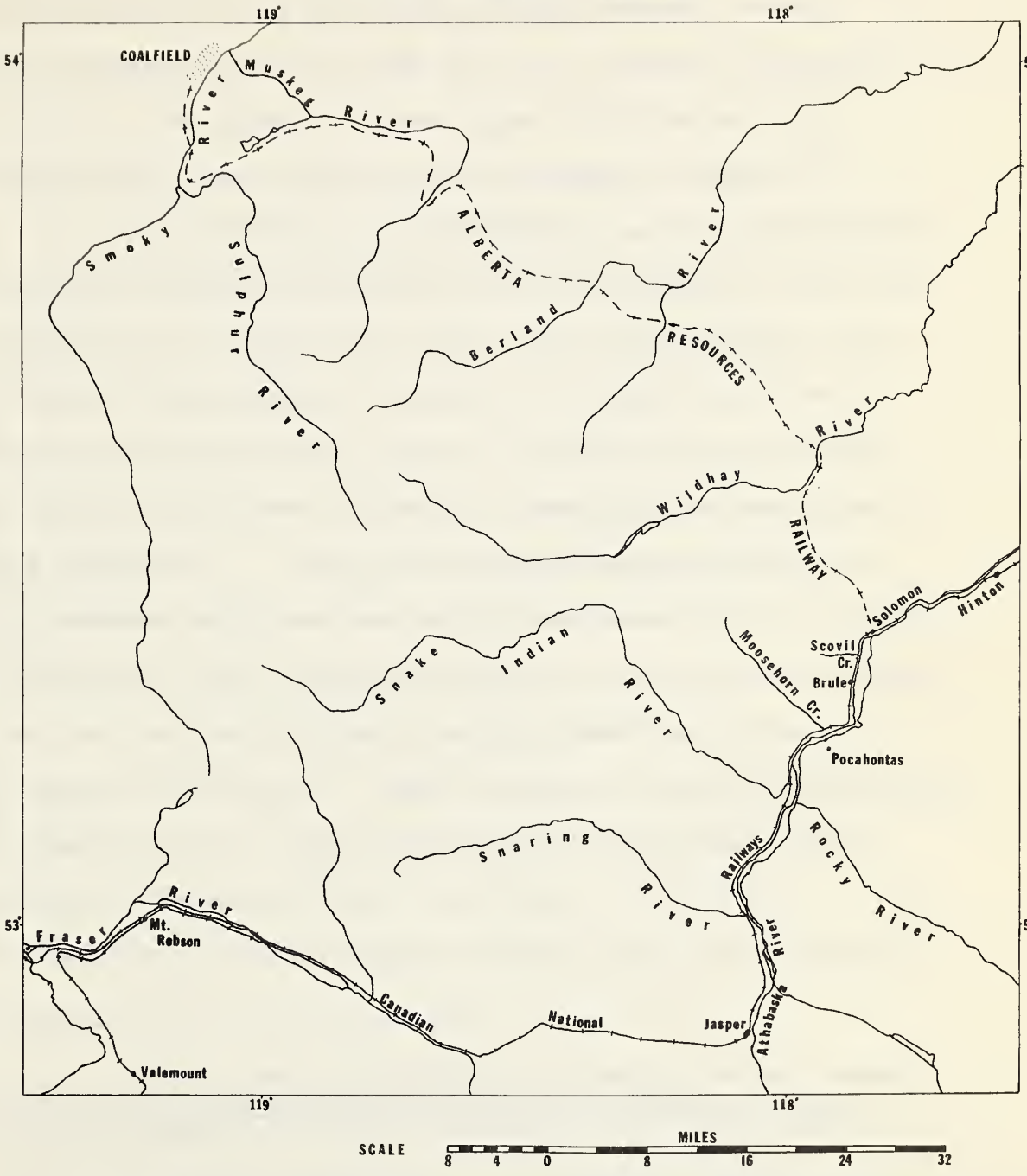
III. The Importance of Coal Mines to the Railroads.

A. The Construction of the Railroads.

It must not be supposed, however, that in the relationship between the railroads and the coal industry, the position of the latter was one of definite subordination and dependency. It is true that access to rail transport was an absolute necessity for a major mine and that many of the big bituminous mines were established along the transcontinental routes as children of the railroad. Yet it is also true that the existence of the Alberta coal deposits made

FIG. 10

SMOKY RIVER COALFIELD and ALBERTA RESOURCES RAILWAY



the operations of the railroads immeasurably easier, and was a major factor in facilitating the construction of the C.P.R. and later the G.T.P.R. in such relatively short periods of time. This statement was made in 1964 by a C.P.R. official, who added that ". . . the growth of railway plant facilities has, to a large extent, paralleled the growth of mining in Canada."[13]

This condition of interdependency was especially important during the planning and construction of the railroads. Just as the location of coal mines later became tied to the railroads, so the location of coal deposits originally was an important factor in determining the major rail routes. "If the prairie and foothills of Alberta had not been successful in supplying considerable coal for locomotives . . . much of the railway construction work in the mountains would have been delayed considerably."[14] Sir Sandford Fleming, the C.P.R.'s Engineer-in-Chief of Construction, in deciding upon the route to be followed, carefully noted the location of reserves of steam coal.[15] Among the sources he used were the articles written by George M. Dawson of the G.S.C. After Dawson's 1882 studies in the Bow and Belly River region, he wrote that " . . . it is doubtless on this belt of coal-bearing rocks in the vicinity of

---

[13]N. F. Cowie, "The Role for Railways in Western Canada", Proceedings, Sixteenth Dominion-Provincial Conference on Coal, Sept. 3-4, 1964, p. 7.

[14]Canada, Royal Commission on the Coal Industry of Canada. Submission on the Coal Resources and Coal Industry of Alberta, Edmonton, 1945, p. B-2.

[15]H. H. Beach, The Geology of the Coal Seams of Edmonton and District and a History of their Mining Development, unpublished M.Sc. thesis, University of Alberta, Edmonton, 1934, p. 23.

the mountains that the railways of the Northwest will chiefly depend for their supply."[16] He was even more enthusiastic in his report three years later, after detailed studies in the Cascade Coal Basin near Banff. "Its occurrence on the line of the railway (which actually runs on the Cretaceous rocks for a distance of thirteen miles), taken in connection with the excellent quality of the fuels which it is capable of affording must be considered as a circumstance of the first economic importance."[17] Later when construction of the G.T.P.R. was underway from the east, the 1906 plans of the G.S.C. included geological surveys aimed at discovery of good steam coal easily accessible from the proposed Yellowhead Pass route. The surveys were successful, resulting in the discovery of the Scovil Creek deposits in the Athabaska Valley, (see Fig. 10) and, farther afield, the Coal Branch deposits.

B. Coal Traffic

Not only did the coal reserves facilitate railroad construction in the west. In their shipments to distant markets, the Alberta mines also provided the railways with one of their leading sources of revenue.

Though the actual coal tonnages transported by rail in western Canada have declined considerably since World War II due

---

[16]George M. Dawson, "Preliminary Report on the Geology of the Bow and Belly River Region, North-West Territory, with Special Reference to the Coal Deposits", Geological and Natural History Survey of Canada, Report of Progress, 1880-81-82, part B, p. 20.

[17]Idem, "Preliminary Report on the Physical and Geological Features of that Portion of the Rocky Mountains between Latitudes 49° and 50°30'", Geological and Natural History Survey of Canada. Annual Report, vol. 1, 1885, Part B, p. 133.

to the general decline in Alberta coal production, the proportion of total coal output which is moved by rail remains as high as ever. Here it is useful to note trends in the United States since Canadian patterns in the industry have followed very closely American trends for half a century. In the U.S., railroads still account for shipment of 80 per cent of the coal output, despite the increase in truck traffic and the attention given to waterborne traffic, particularly on the Ohio-Mississippi system. Moreover, authoritative sources foresee no significant trend in this pattern in the immediate future.[18]

In western Canada, waterborne traffic is virtually nil. Moreover due to the decline in the number of small mines serving the local household fuel market, truck traffic remains definitely subordinate. There are very few large mines which ship more than 20 per cent of their output by truck.[19]

IV. Availability of Rolling Stock for Coal Movements.

It would appear then that the fortunes of Alberta's major mines, excluding those oriented to power stations located on the coalfields, will continue to be linked with the railroads. The question then arises which R. E. Murphy posed with reference to the Appalachian coalfield: "To what extent did the coal mines merely take

---

[18] S. H. Schurr and B. C. Netschert, Energy in the American Economy, 1850-1975, Baltimore, 1960, p. 342.

[19] Exceptions include the major strip mines at Wabamun and Battle River (see Fig. 4) where the coal is transported from the strip pits to the generating station by trucks with capacities of fifty-one tons. Haulage distance in these cases is less than five miles.

advantage of railroads built for other purposes, and to what extent were the railroads built with this rich freight specifically in mind?"[20]

There were some cases where the railroads were built specifically to provide access to coalfields, the best examples being the Coal Branch and Brazeau Branch. Even here, however, the objective of the railways was not to enable them to increase their freight revenues by hauling coal, but more importantly to give them access to fuel for their own steam locomotives. Aside from these cases it would be fair to say that the coal mines in Alberta took advantage of railroads built for other purposes.

The other purposes involve mainly the provision of transport facilities for the agricultural exports of the prairie region. Quite simply railroads in the prairie provinces are tied primarily to shipment of grain and more specifically wheat. Other freight receives secondary consideration and is hauled chiefly in grain's off-season. Yet coal mining for the domestic fuel market has always been most intensive in autumn and winter, precisely the period when virtually all rolling stock is engaged in grain shipments. The result is that throughout its history, Alberta's coal industry has been plagued by an inadequate availability of railroad cars. The problem was referred to in 1948 by an official of one mining firm as "the ancient bugbear".[21]

---

[20]R. E. Murphy and H. E. Spittal, "A New Production Map of the Appalachian Bituminous Coal Region", AAAG, vol. 34, 1944, p. 171.

[21]Terry Smith, "Monarch is Completely Mechanized", Western Miner, August 1948, p. 81.

One possible solution would be the shipment of coal during grain's off-season. This, however, would necessitate storage of coal for extended periods of time. Storage not only adds to the total costs but also results in deterioration of the coal, especially of the lower rank domestic coals such as those of the Drumheller district. Attempts over the last half century at practical, inexpensive storage of Alberta sub-bituminous coals have all proved fruitless.

The problem of inadequate supply of railroad cars has hurt Alberta's coal industry in several ways. It has in many cases been a direct cause of reduced production. John Crawford, Alberta's chief inspector of mines, estimated that Alberta mines lost 327 operating days in 1948 during the post-war peak due to a shortage of cars. This represented a loss in production of about 320,000 tons.[22] At other times a shortage of cars, though it may not actually limit output, does add considerably to a mining firm's storage and handling costs.[23] Moreover the knowledge that rail shipments may be irregular has discouraged potential consumers from purchasing Alberta coal. This was one reason given by operators of the Granby thermal power station at Princeton, B.C., for their reluctance to rely on Alberta coal.[24]

---

[22]John Crawford, "Alberta Coal Output in 1948", Western Miner, April 1949, p. 93.

[23]Pers. comm., R. Upton, Coleman, Aug. 6, 1965.

[24]W. I. Nelson , "Sources of Coal Supply for the Granby Plant", Western Miner, December 1948, p. 75.

V. The Importance of the Railroad Market to Alberta Mines

A. The Pre-War Market.

As important as the railroads have been, however, in giving Alberta coal access to distant markets, they have been far more important as markets themselves, particularly for the bituminous mines. The pattern was already well-established by the 1920s.

TABLE V[25]

PERCENTAGE OF ALBERTA BITUMINOUS OUTPUT SOLD TO RAILROADS, 1920-1925.

Year	Percentage
1920	73.3
1921	69.6
1922	75.8
1923	88.3
1924	84.6
1925	86.2

At this time Alberta coal mines supplied the fuel for C.P.R. and C.N.R. use in all of Alberta and Saskatchewan, practically all of Manitoba, and a large part of British Columbia.

---

[25]Alberta, Report of the Alberta Coal Commission, 1925, Edmonton, 1926, p. 120.

Quite naturally there was a well-defined pattern of consumption, with each railroad depending mainly upon high volatile bituminous from operations along its own lines. Thus the C.N.R.'s main suppliers were Brazeau Collieries and the western arm of the Coal Branch. The C.P.R. similarly depended upon Canmore and the Crowsnest Pass mines. In addition the railroads purchased considerable amounts from the mines of the so-called "Outer Foothills Belt".[26] This included the Pincher Creek district, the eastern arm of the Coal Branch, and the Prairie Creek district. These coals were generally of lower rank, however, and were used by the railroads only after blending with the higher rank Lower Cretaceous coals. The large strip operations at Sterco and Coal Valley on the eastern arm of the Coal Branch are leading examples of this market pattern. By 1948, two-thirds of their output went to the C.N.R. for eventual use as locomotive fuel after blending with higher rank coals.

The overdependence on the railroad market of a large number of Alberta coal mines placed the industry in a tenuous position. In 1928 at the height of an economic boom period, Alberta mines sold over 3,000,000 tons to the railroads. Five years later, with the country in the depths of the Great Depression and rail traffic (notably grain) greatly reduced, the tonnage sold to railroads was less than half of what it had been in 1928.[27]

---

[26] B. R. MacKay, Coal Reserves of Canada, Ottawa, 1946, passim.

[27] Canada, Royal Commission on Dominion-Provincial Relations, Submission of the Western Canada Fuel Association, Ottawa, 1938, app. 2, c.

One difficulty facing the mines when they were so heavily dependent upon the railroad market was that the latter fluctuated seasonally due to the greater activity of the railroads during the grain shipping season. To serve a seasonally fluctuating market, the mines themselves were almost forced into a pattern of seasonally fluctuating output with the attendant problems of labor supply and reduced rates of efficiency. The Evans Commission of 1925 (provincial) and the Carroll Commission of 1945 (federal) both alluded to this problem, indicating that over the intervening period no solution had been found which might have regulated the railroad market.[28]

Not long after the Carroll Commission, however, a much more serious problem confronted the coal industry. It became increasingly evident that the problem was not one of regulating the railroad market, but one of simply maintaining it at all. The threat of a changeover from coal-fired steam locomotives to diesel powered locomotives was very real.

Overdependence on the railroad market had long been recognized as one of the major problems faced by Alberta's bituminous mines. The Barlow Commission of 1935 included the following figures (Table VI).

The situation had not improved by the end of World War II. It was still true that without exception every major bituminous mine in Alberta sold at least half its output to the railroads. Even a

---

[28]Alberta, Report of the Alberta Coal Commission, 1925, op. cit., passim.
Canada, Report of the Royal Commission on Coal, 1946, Ottawa, 1947, passim.

TABLE VI[29]

PERCENTAGE OF ALBERTA COAL SOLD TO RAILROADS, SELECTED YEARS, 1928-1934.

Year	Bituminous	Sub-bituminous	all Alberta coal
1926	85.6	46.5	41.5
1928	84.1	46.9	44.0
1930	61.1	46.7	39.1
1932	78.0	47.6	35.7
1934	74.8	47.0	38.7

[29]Alberta, Report of the Royal Commission Respecting the Coal Industry of Alberta, Edmonton, 1936, p. 122.

It should be noted that a third category of Alberta coal was still in use at the time of this report. Very little of this coal, known as domestic coal, was sold to railroads. Hence the figures in the third column are lower than those in either of the other two columns.

company like International Coal and Coke of Coleman with a complex operation linked partially to metallurgical markets, still sold sixty-five percent of its output to the railroads in 1948. Elsewhere in the Crowsnest, the percentages were even higher with all told about seventy percent of the output of this Coal Area's output sold to the railroads. On the western arm of the Coal Branch percentages were still higher with about 75-85 percent of the coal from Luscar, Cadomin, and Mountain Park being sold to the C.N.R. Probably the most extreme example was Brazeau Collieries where from 1920 to 1950 over ninety percent of production went to the railroads.

B. Dieselization.

The future of these mines so dependent upon the steam powered locomotive became uncertain when in 1948 the C.P.R. began to dieselize its system. Diesel locomotives have several advantages over the coal-fired type. Their energy use efficiency of twenty-five percent is much higher than the four percent for steam locomotives.[30] Moreover, diesels have lower overall operating and maintenance costs, and they require no water.

Despite these very considerable advantages of the diesel locomotive, a full changeover was not expected to occur for some time. C.P.R. officials stated in 1948 that dieselization would take ten years at the very least and that some steam locomotives would

---

[30]John Davis, Canadian Energy Prospects, Ottawa, 1957, p. 348.

remain in service indefinitely. A firm of management consultants stated in 1953 that ". . . some 15 to 20 years will be required to effect this changeover to diesel locomotives ."[31]

There were attempts from some quarters to delay dieselization or even to halt it. Predictably these were made by representatives of the bituminous coal operators and miners as well as the provincial governments of Alberta and B.C. A joint submission to the federal cabinet from these sources requested that the government require the railroads to maintain a certain number of coal-fired locomotives.

Notwithstanding the forecasts of experts, the protestations of those in the bituminous coal industry, and the statements of railroad officials themselves, dieselization progressed rapidly, aided by rising coal prices and falling diesel fuel prices. The C.N.R. did not begin its changeover until after the C.P.R., yet by 1954 the former had virtually eliminated the use of Canadian coal. By 1956 the C.P.R. had reached a similar position. Dieselization was carried out more quickly by the C.N.R. since the coal reserves upon which it had largely depended were not on through continental routes and thus were much less favorably located than the mines which serviced the C.P.R.

The magnitude of the changeover is reflected in the figures of Table VII.

---

[31] J. D. Woods and Gordon Limited of Toronto, Survey of the Market for Underground Mined Coal, Calgary, 1953, p. 8.

TABLE VII[32]

RAILROAD LOCOMOTIVES IN USE IN WESTERN CANADA

	coal-burners	diesels
1948	1,415	34
1955	707	440

By 1961 there was not one coal-burning engine in service on Canada's two transcontinental systems. A market which in 1949 had consumed 13 million tons of coal had thus almost completely disappeared.

Loss of the railroad market was a great blow to Alberta's bituminous mines (see Figs. 6 & 13). Prior to dieselization, bituminous coal comprised two-thirds of Alberta's total output. It now accounts for considerably less than one half. The situation is not unique to Alberta. In the United States 132 million tons of coal was used as railroad fuel in 1944. By 1958 the amount was less than four million tons.[33]

With the advantage of hindsight, it is interesting to look back in an attempt to determine whether or not those involved in Alberta's coal industry were aware of the threat posed by dieselization. Evidently they were. The 1925 Evans commission contained

---

[32]Idem., Survey of the Market for Underground Coal, 1956, p. 28.

[33]United States Bureau of Mines, Mineral Facts and Problems, Washington, 1960, p. 112.

the following statement: "If any new source of oil develops that will give it at a lower price to the railways, it might have an important bearing on the consumption of coal in western Canada."[34] Ten years later, apparently, the threat was still more widely recognized. In their submission to the 1935 Barlow Commission, the bituminous coal operators noted that, "If the policy of the Railway Companies was to be a large extension of oil consumption, this would seriously affect the coal industry of the West. . . ."[35]

In the light of these statements made thirty and forty years ago, it is difficult to understand how the following statement could appear in the submission of the Alberta government to the Carroll Royal Commission of 1946. "Our Canadian railways have in the past been the greatest and most stable market, year in and year out, for Alberta coal. Great and stable as this market has been it is our considered view that this market is capable of absorbing still larger tonnages and on a firmer basis than in the past."[36] Less than one decade later, the C.N.R. had virtually completed its dieselization program.

The above statement was made just after the end of World War II. During the war the province's coal industry had been hard-pressed to

---

[34]Alberta, Report of the Alberta Coal Commission 1925, Edmonton, 1926, p. 122.

[35]Alberta, Report of the Royal Commission Respecting the Coal Industry of Alberta, 1935, Edmonton, 1936, p. 96.

[36]Canada, Royal Commission on the Coal Resources and Coal Industry of Alberta, Edmonton, 1945, p. G-8.

meet the increased demands. Apparently this feverish activity lulled some of those in the industry into a false sense of security. The years immediately after the war seemed to warrant some degree of optimism as Alberta's output reached an all-time high. But in 1948 C.P.R. dieselization began and it was soon evident that the optimism was unfounded. The Seventh Annual Mines Ministers' Conference was held in Victoria in 1950 and the following statement was made by the Coal Committee:

> Railway companies at present use approximately 3,000,000 tons of Western Canadian bituminous coal and this represents about sixty percent of total production. Without this tonnage . . ., the Western Canadian bituminous coal industry would cease to exist. . . . The elimination of bituminous coal production would in time retard the industrial development of the West with consequent adverse effect on the railways themselves."[37]

It is interesting to examine this statement more closely in the light of events during the fifteen years since it was made. The railroad market has been eliminated, and though the western Canadian bituminous coal industry has not ceased to exist, it survives today in greatly reduced form. Of about one dozen major bituminous mines in existence in Alberta in 1950, only two are still operating today--Canmore and Coleman.

VI. The Present Relationship Between Coal and the Railroads.

The last part of the above statement is interesting in that it alludes to the historic link between the coal industry and

---

[37]"The Western Coal Problem", Western Miner, vol. 23, No. 10, October, 1950, p. 50.

the railroads. For decades they had been mutually dependent. Prosperity for one meant prosperity for the other. The statement contended that in effect this link still existed, that without a prosperous bituminous coal industry in western Canada, the railroads themselves would suffer greatly. This, however, has not transpired. The link has now been broken. Assuredly there is still a very important relationship between the railroads and the coal industry but it is no longer one of approximate mutual dependence. The railways, powered by their diesel units, no longer need the coal industry. Admittedly, the revenue for hauling coal is welcome, but it is not essential to the survival of the railways. In contrast the coal mines still depend greatly on the railways, to provide access to markets. In the new relationship between the two industries, the coal industry is definitely in a subordinate position.

A. Freight Rates.

The new relationship, more than ever before, can be reduced to one question--freight rates. For nearly a half-century, representatives of Alberta's coal industry have lobbied for lower freight rates which would effectively increase their market area. Boards and organizations which have been set up to study or oversee all aspects of the coal industry have come in the end to be almost entirely preoccupied with the subject of freight rates and its concomitant, transport subsidies. This was true of the Dominion Fuel Board (D.F.B.), established in 1923 in the hopes of removing some of the uncertainties from Canada's coal sources. Creation of the board was prompted by serious coal shortage in Canada during the winter of

1922-23 as a result of a total strike of Pennsylvania coal miners. Dependability of U.S. sources of supply became even more uncertain when in 1923 Congress discussed a bill to place an embargo on export of coal to Canada. The bill, promoted strongly by American conservationists, failed to pass, but nevertheless had strong repercussions in Canada.

Many Canadians speculated on the extreme danger of over-dependence on an external source to meet their fuel requirements. A National Fuel Policy was formulated in 1923, its aim being the stimulation of Canadian sources of coal. Negotiations between the C.N.R. and the Government of Alberta led to the trial shipment of 17,000 tons of Alberta Coal to central Canada in the summer of 1923. Further talks, in which the Governments of Canada and Ontario also participated, resulted in the rail shipment of 75,000 tons to widely scattered Ontario points between June, 1925, and April, 1926. Producing centers included Edmonton, Evansburg, Drumheller, and Wabamun (see Fig. 2). All shipments were studied closely by the D.F.B. in an attempt to determine the economic feasibility of large-scale movements of coal on a regular basis.

The crux of the situation in formulating a fuel policy was succinctly noted by one of Canada's leading railwaymen, Sir Hugh Stutchbury. "There is not a fuel problem in Canada. The problem is one of transportation and distribution of the immense fuel resources of Canada from their point of origin to their place of consumption."[38]

---

[38]H. L. Draper, The Alberta Coal Problem, Montreal, 1930, p. 36.

The essence of his statement is contained in an old saying which is superficially trivial but which in fact alludes to a situation of great import to the Canadian economy: "Canada is a country with coalfields at both ends and railways in between."[39] (see Fig. 12).

The problem facing Canada's coal industry is thus basically one of spatial relationships. The leading region in Canada with respect to coal consumption is the St. Lawrence-Ontario Lowland, where most of Canada's population and economic activity are concentrated. It is this market which has always been the central factor in the minds of those planning a national coal policy. However, two thousand miles separate this lucrative market from Alberta's coalfields. In contrast the coalfields of the eastern United States are much more favorably located to serve the coal deficient manufacturing areas of central Canada. Toronto is less than 400 miles from the Pennsylvania coalfields and over much of that distance inexpensive water transport can be utilized (see Fig. 12).

B. Rail Subsidies on Transport of Coal.

It was therefore obvious at an early date, that if Alberta coal were to even partially displace American coal in Ontario, subsidized freight rates would be required. Several schemes were tried in the 1920s with subsidies from the federal government and those of the two provinces involved. Yet even with the aid of subsidies, sales of Alberta coal in Ontario were rarely of major significance either to the Alberta coal industry or to Ontario's total consumption patterns. (see Fig. 13).

---

[39] F. W. Gray, op. cit., p. 58.

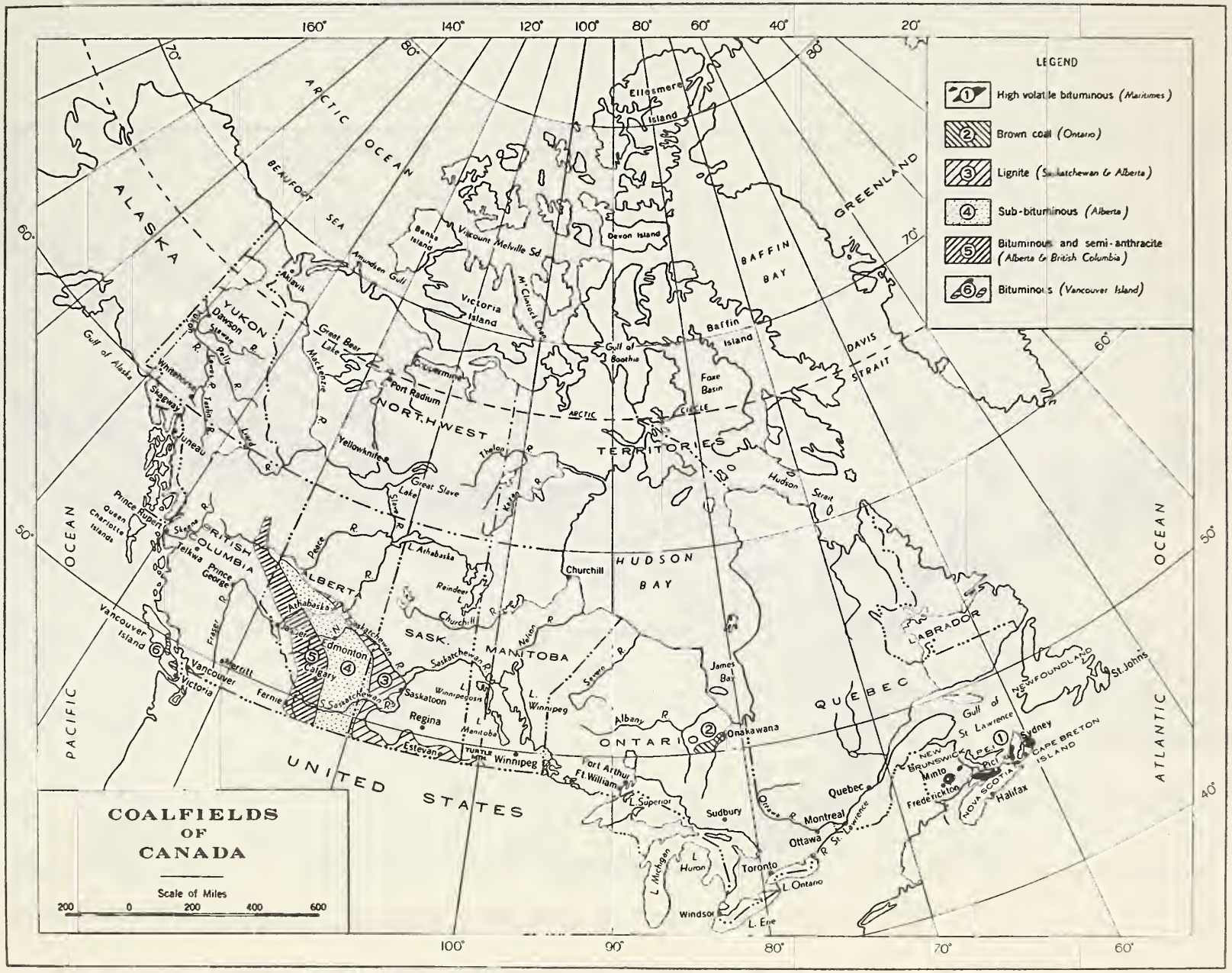


Fig. 11: E. Swartzman, Analysis Directory of Canadian Coals, Ottawa, 1953.

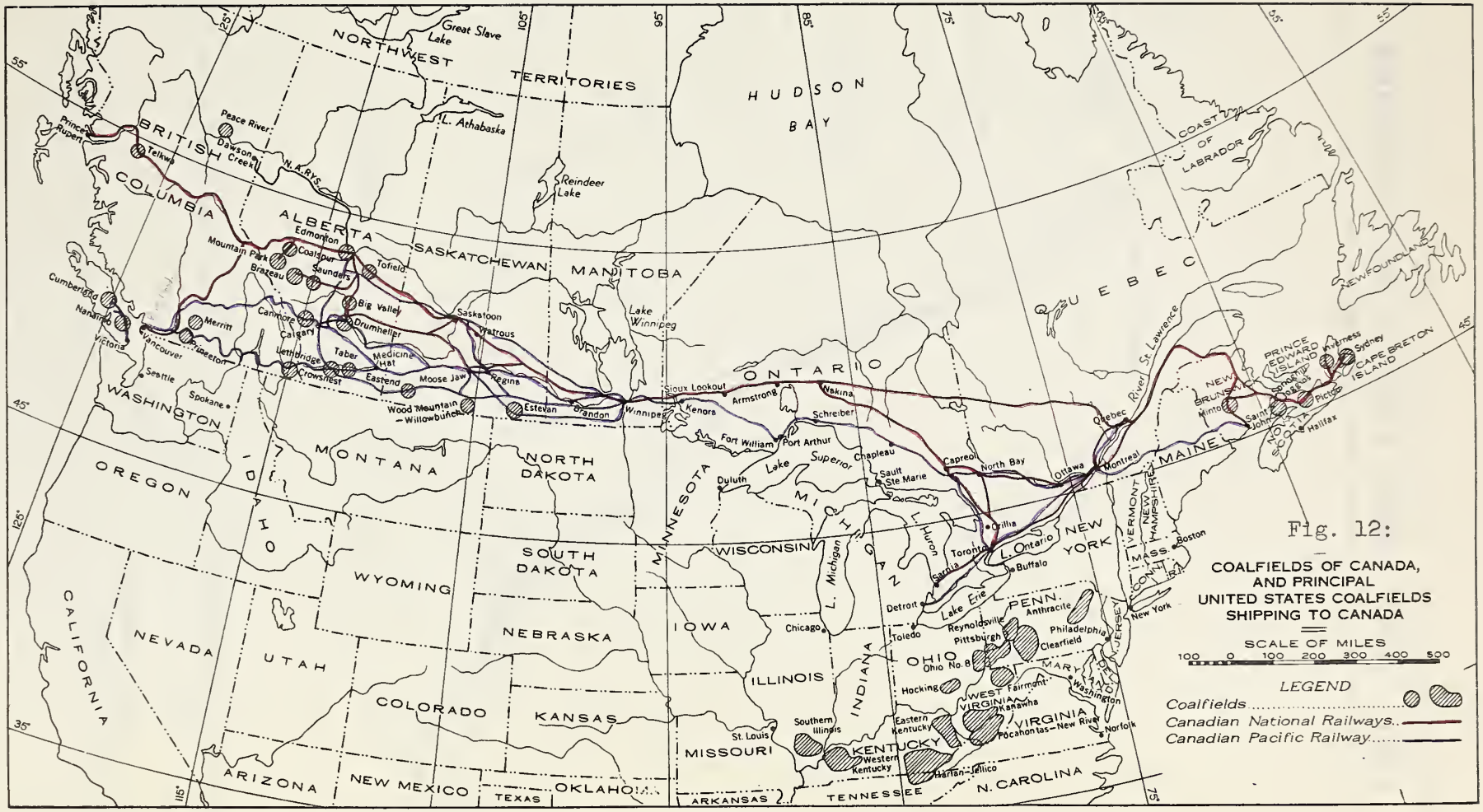
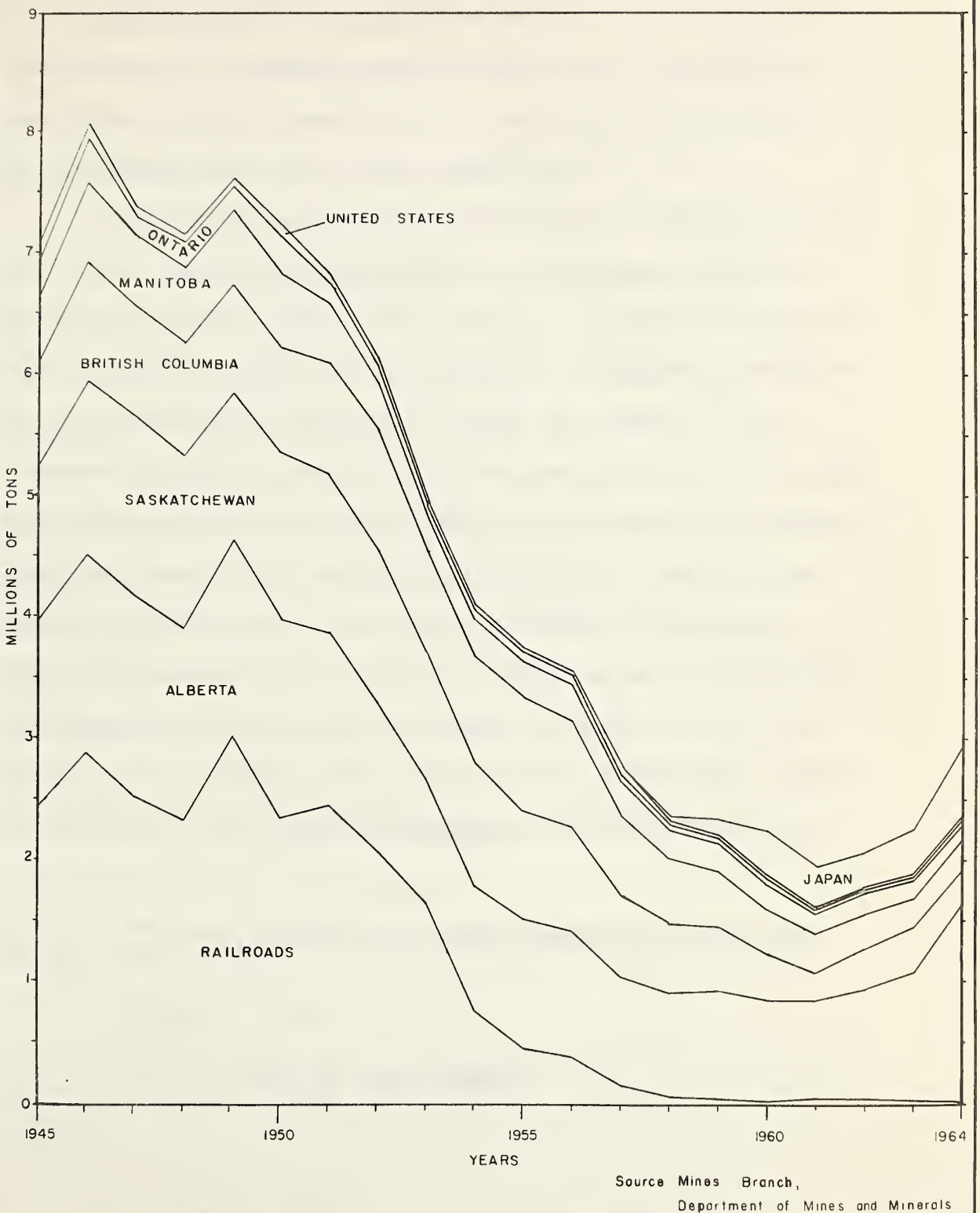


Fig. 12:

Source: Canada, Report of the Royal Commission on Coal, 1946, Ottawa, 1947.

FIG 13

MARKETS FOR ALBERTA COAL, 1945 - 1964



Source Mines Branch,
Department of Mines and Minerals

At the time of the Carroll Commission in 1945-46, the question of rail subsidies was still a topic of major interest and controversy. Commissioner A. J. Morrison advocated that they be continued, but only after the establishment of ". . . geographical limits within which Canadian coal would be made competitive."[40]

With these words Morrison apparently put forward the view that total Canadian self-sufficiency in coal, though physically possible, was and is economically absurd. The Commission estimated that the cost to Canada of maintaining such "independence" would be at least $100 million annually.[41] Though some romantics[42] and promoters of autarchy reminiscent of the Fascist states of the 1930s favor total exclusion of any foreign coal from Canada, most objective observers concur in the conclusion of the Carroll Commission that total self-sufficiency in coal would be completely impractical. Even lobbyists for the coal industry call for no more than a partial displacement of American coal in Ontario by Canadian coal. A submission by the industry to the cabinet in 1954 stated that, "Should ten percent of this [Canadian] consumption of United States coal be

---

[40]Canada, Report of the Royal Commission on Coal, 1946, Ottawa, 1947, p. 596.

[41]Ibid., p. 582.

[42]F. W. Gray, op. cit., passim.

supplied from western Canadian sources the decline in the western coal industry would be averted and the industry would be stabilized."[43]

This statement represents quite widely held opinion in Canada. Though few realists contend that foreign coal should be excluded completely, they do favor some form of economic assistance for western Canada's coal industry. Why is such aid deemed justified?

1. Social Reasons for Coal Subsidies. Regionally the coal industry is a very important source of employment. This is especially true in parts of Nova Scotia. In Alberta, though the proportion of families dependent upon the coal industry is not as great as in Nova Scotia, there are specific areas which are largely dependent upon coal (see Fig. 17). These include the Crowsnest Pass and Canmore today, and once included many more settlements such as those on the Coal Branch. It has thus been a long-standing argument that aid to the coal industry keeps the miners and their families off relief and therefore actually represents a saving to the taxpayer. The coal operators correctly point out that in their industry there is a far larger proportionate expenditure for salaries and wages, taxes and licences in distribution centers than is the case for competitive fuels. About fifty percent of the money received in

---

[43]Canada, Submission to the Federal Cabinet by a delegation representing District 18 of the United Mine Workers of America, The Coal Operators' Association of Western Canada, and the Provincial Governments of British Columbia, Alberta, and Saskatchewan, Ottawa, 1954, p. 2.

coal sales is paid out in wages, a much higher percentage than holds true for the oil, natural gas, or electric power industries.[44]

2. Problems in Re-opening Abandoned Mines. One argument advanced by the coal operators to support their requests for assistance is that a skeleton of the industry must be maintained to facilitate expansion in the future when the demands for coal begin to grow rapidly as they invariably must, consequent on the exhaustion of other energy sources. It is very costly and difficult to re-open abandoned mines. Often flooding has occurred and shoring has rotted. If adequate aid is available for the coal operators, the mines can be maintained continuously in a proper manner.

3. National Security. The previous argument has often been reinforced by claims that a healthy coal industry is vital for Canada's national security, that the industry must be maintained in such a condition that it can be expanded rapidly to meet any emergency. This contention was especially common during and immediately after World War II, and is still put forward on occasion. A submission to the federal cabinet in 1954 by the coal industry included the following statement: "The [coal] mining industry is an absolute necessity to our national welfare and existence and thus it is essential that the Federal Government take immediate action to preserve it."[45]

---

[44]The fact that coal mining is such a labor-intensive industry is of great significance in the industry's struggle to reduce production costs. The same relationships, of course, do not hold true for large stripping operations.

[45]Canada, Submission to the Federal Cabinet by a delegation representing District 18 of the United Mine Workers of America, op. cit., p. 3.

4. Coal's Importance to the Railways. A healthy coal industry would also be beneficial for the railways. The western grain shipping season lasts about four months. For the rest of the year much of the rolling stock and labor which has been gathered to move grain remains comparatively idle. Increased movement of coal would improve the seasonal efficiency of the railways.

5. Regional Aid. Many of the arguments advanced in favor of aid to Alberta's coal industry relate to the broader questions of national unity and regional development. Generally speaking, Canada's protective tariff benefits Ontario and Quebec where the country's secondary production is concentrated. The West and the Maritimes, however, where the accent is on primary production, find the tariff a liability. Many commissions have thus supported aid to the coal industries of the West and the Maritimes as a method of compensation for these regions.[46] Commissioner Rand in his report of 1960 wrote that "While, then, economic principles may seem to be outraged by the means of support to the coal industry of the past, in the view of the national interest as a whole, their price has been a small item in the general national ledger."[47] Thus the spirit with

---

[46]Canada, Royal Commission on Dominion-Provincial Relations, op. cit., pp. 7, 8.

Alberta, Report of the Royal Commission Respecting the Coal Industry of the Province of Alberta, 1935, Edmonton, 1936, p. 45.

[47]I. C. Rand, Report of Royal Commission on Coal, Ottawa, 1960, p. 7.

which the problems of the coal industry have been faced has been a typically Canadian one of regional compromise. Some may see the attempts to prop up the coal industry as economically absurd, as a throwback to obsolete autarchy in a world where states are becoming increasingly more interdependent. However, in attempting to solve the problems of the coal industry, bare economics has not been the only factor considered. As Rand noted, these problems ". . . have become of concern because of special geographical, industrial and social circumstances."[48]

6. Possible Means of Aiding the Coal Industry. Once the question of whether or not to provide aid for the coal industry has been settled, a further question remains. What mechanism should be used to provide such aid? One method is the tariff, and in fact there has been a tariff on coal imported into Canada almost continuously since 1879. With Canada so dependent on trade, however, it would be imprudent to maintain a high tariff wall. As a result the tariff on coal has rarely been more than one dollar per ton, and has had no marked effect in improving the competitive position of Canadian produced coal in the markets of central Canada. Another method suggested at various times has been a special tax on oil but this has not been implemented.

7. Implementation of Rail Subsidies. As noted, the major problem facing Alberta coal producers is distance to market.

---

[48]Ibid., p. 1.

Not unnaturally, therefore, the type of aid which has become standard is that designed to alleviate this specific problem by the provision of rail subsidies.

(a) The Amount of Subsidization. In a country as large as Canada and one in which concentrations of population are so widely separated, railway freight rates have a great effect on distribution of economic activity. Yet freight rates have commonly been arrived at, not by a reasoned cost analysis but by historical accident, often crystallizing at whatever the market would stand. When one considers the large number of variables involved in rail transport, it is not surprising that the rate structure has developed in this way. Generally the rate from Alberta mines to Toronto and other markets in southern Ontario has ranged from $8 to $13 per ton since the mid-1930s. These transport costs have been sufficiently high to price Alberta coal out of the Ontario market. Thus, rail subsidies, which were begun experimentally in 1924, were firmly established by 1930 and have since been a vital facet of Alberta's coal industry. By April, 1960, more than 14,500,000 tons of coal from Alberta and the Crowsnest region of B.C. had been marketed in Ontario due to aid in the form of rail subsidies totalling more than $29,250,000. Recently they have been about $2.50 to $3.50 per ton, though they once ranged as high as $5.96 in 1928. A submission to the cabinet by the coal industry in 1954 concluded that subsidies of $5.50-$7.50 per ton would be needed to enable Alberta coal to compete effectively with that of the U.S.[49]

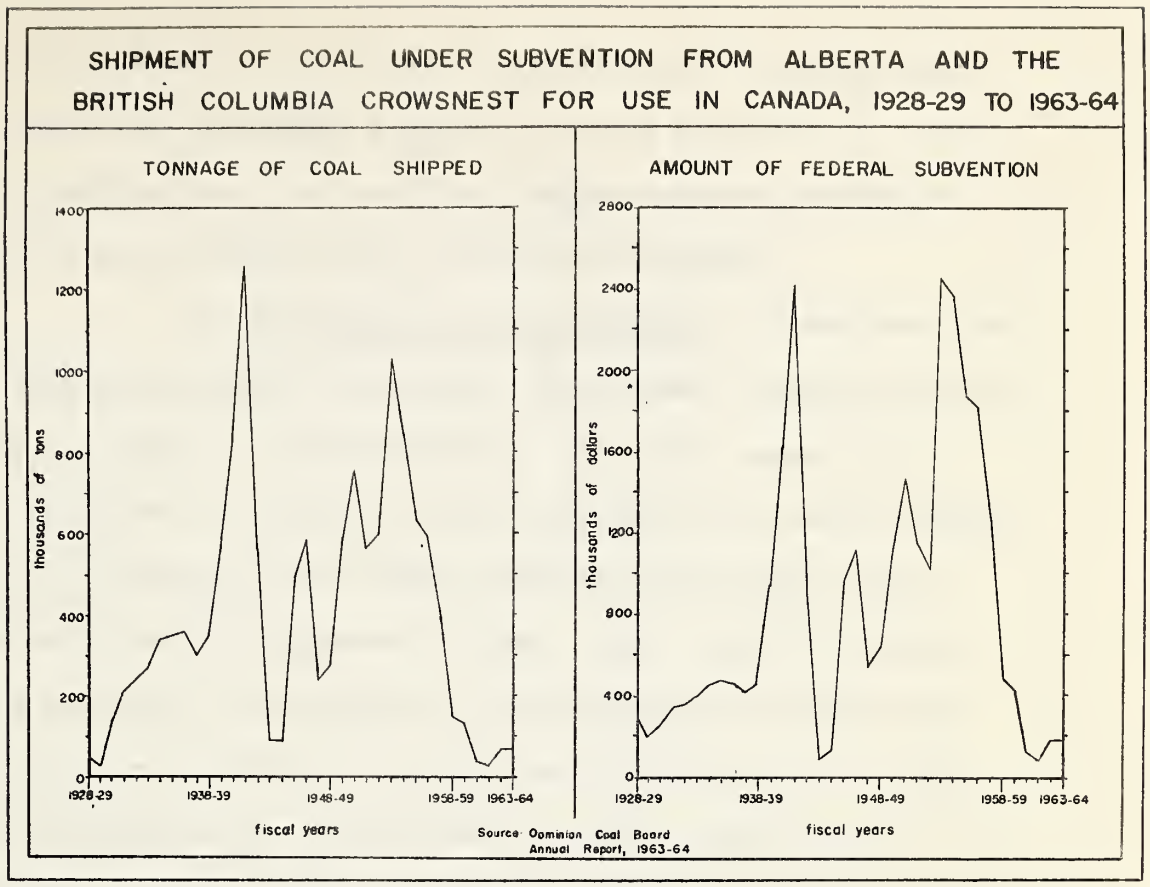
---

[49]Canada, Submission to the Federal Cabinet by District 18, et al, op. cit., p. 34.

(b) Subsidized Exports. Recently there has been a basic change in the aims of the coal subsidization policy. Originally the subsidies were intended to provide Canadian coal for Canadian consumers, after U.S. sources of supply proved unreliable in the 1920s. In 1949, however, provision was made for payment of transport subsidies on Alberta coal being moved to export markets other than the U.S. Quite obviously the government's main concern was no longer centered on possible coal shortages for Canadian consumers but on the depressed coal industry itself with attendant problems of unemployment and loss of capital investment. Hence by 1960 the amount of subsidies paid on western Canadian coal bound for export markets was nearly triple that paid on coal moving to Ontario markets (see Figs. 14 & 15). However, the subsidy per ton remains less on export-bound coal.

The specific export market of greatest importance is now Japan. For this market Canadian producers are competing against mines in the U.S. and Australia and are at a distinct disadvantage because of the long rail distances they face. Canmore is about 560 rail miles from the Port Moody docks and Coleman is more than 700 miles. To enable producers in these areas to compete in the Japanese markets, the federal government has paid a special rail subsidy since 1959. Payment is conditional in that the operators are expected to modernize their plant, increase their efficiency, and make their operations more economically viable, thus permitting gradual reduction of the subsidy. This has in fact happened. In 1959 it stood at $4.50 per ton of coal moved by rail from Alberta to the B.C. coast. It has since been reduced to $3.50, then $3.15, and now stands at $2.73. When coal bound for export markets is included, about 16.8 million

Fig. 14:


SHIPMENT OF COAL UNDER SUBVENTION FROM ALBERTA AND THE BRITISH COLUMBIA CROWSNEST FOR USE IN CANADA, 1928-29 TO 1963-64
TONNAGE OF COAL SHIPPED
thousands of tons
1400
1200
1000
800
600
400
200
0
1928-29
1938-39
1948-49
1958-59
1963-64
fiscal years
AMOUNT OF FEDERAL SUBVENTION
thousands of dollars
2800
2400
2000
1600
1200
800
400
0
1928-29
1938-39
1948-49
1958-59
1963-64
fiscal years
Source: Dominion Coal Board Annual Report, 1963-64

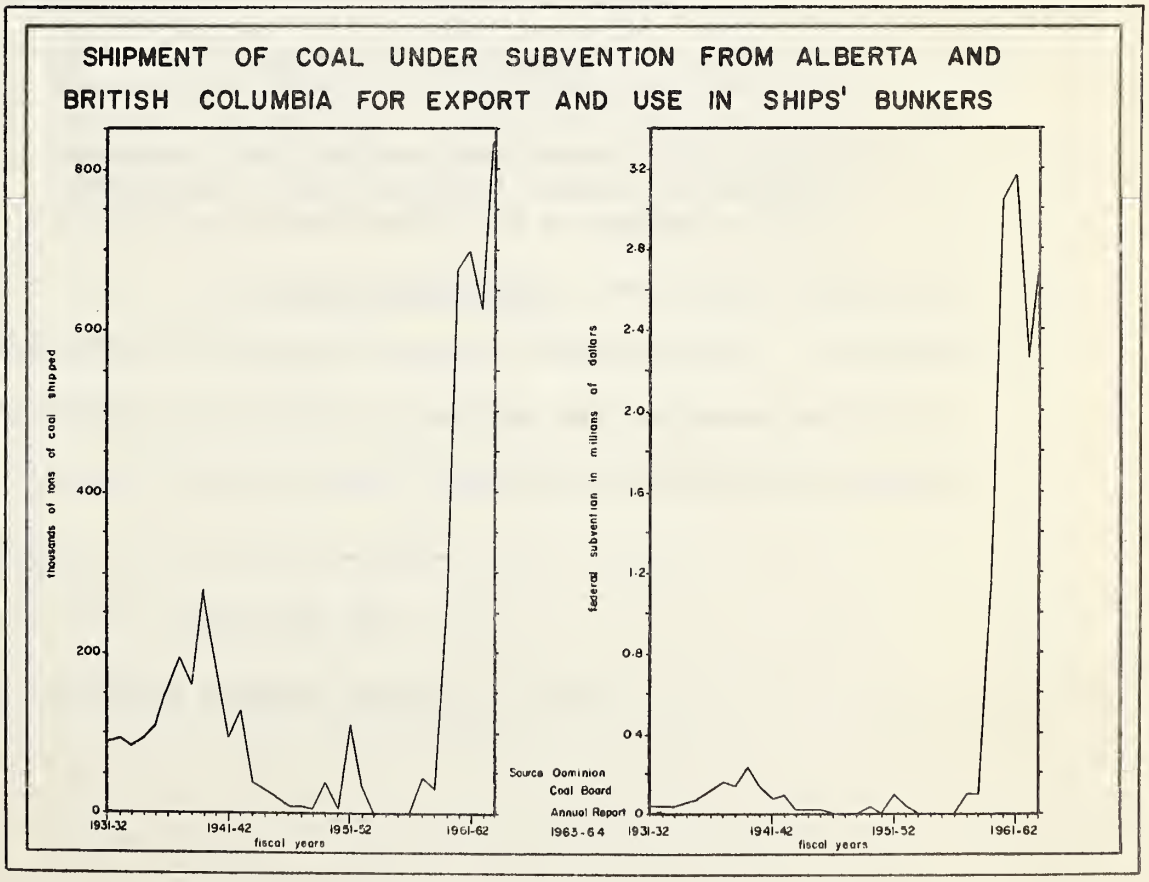

SHIPMENT OF COAL UNDER SUBVENTION FROM ALBERTA AND BRITISH COLUMBIA FOR EXPORT AND USE IN SHIPS' BUNKERS
thousands of tons of coal shipped
800
600
400
200
0
1931-32
1941-42
1951-52
1961-62
fiscal years
federal subvention in millions of dollars
3.2
2.8
2.4
2.0
1.6
1.2
0.8
0.4
0
1931-32
1941-42
1951-52
1961-62
fiscal years
Source Dominion Coal Board Annual Report 1963-64

Fig. 15:

tons of Alberta and B.C. Crowsnest coal were moved by April, 1960, under subventions totalling $32.1 million (see Figs. 14, 15, & 16). It is significant that the subsidized tonnage amounted to only 6.7 per cent of total output during that period 1928-1960.[50]

(c) The Success of Coal Subsidies. Detractors from the subsidization program contend that the economic assistance merely prolongs the agony of a dying industry. This would appear to be unfair criticism. The only two Alberta operators who benefit greatly from the rail subsidies are Coleman Collieries and Canmore Mines, both of which are very progressive firms. Their survival combined with the cessation of operations by less progressive and efficient firms would seem to indicate that the subsidization policy has had results in keeping with the government's aims as enunciated by federal Mines Minister, George Prudham, in 1953.

> Government support and assistance . . . within that area of free enterprise should have full scope to maintain competition, to weed out the inefficient operators, to eliminate those mines where approaching exhaustion or other physical conditions preclude production of good quality at a reasonable cost."[51]

(d) Tenure of Subsidies. One difficult problem associated with the subsidies has been that of tenure. If they are to fully benefit the industry, subsidies must be guaranteed for a certain length of time to permit operators to make definite plans

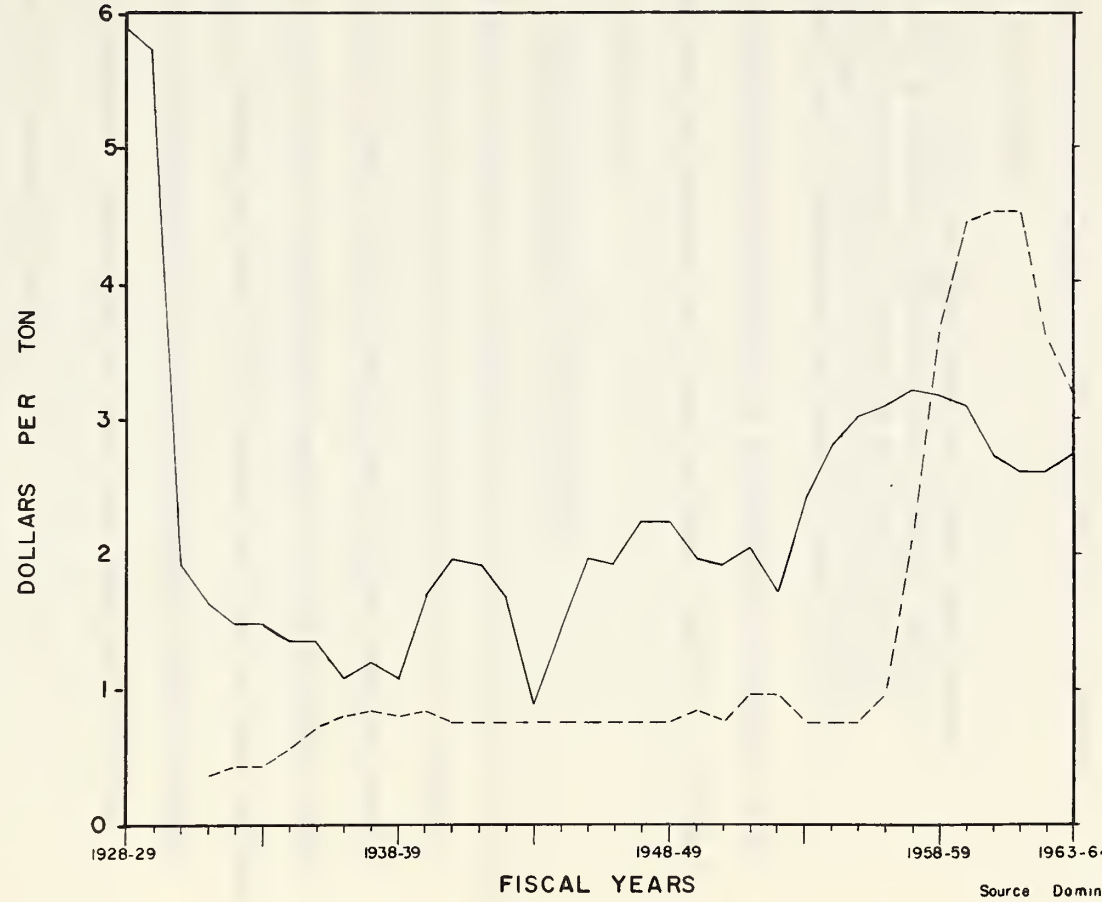
---

[50] I. C. Rand, op. cit., p. 2.

[51] George Prudham, op. cit., p. 40.

SUBVENTION PER TON ON COAL SHIPPED FROM ALBERTA AND BRITISH COLUMBIA, 1928-29 TO 1963-64

FIG. 16



Source Dominion Coal Board Annual Report, 1963-64

with respect to expansion and allocation of capital. This fact has been recognized for many years, with long term subventions being one of the recommendations of the Carroll Commission in 1946.[52] Its importance is realized today in all quarters--the industry itself, government, and among leading coal consumers. The Canadian representative of Japan's large industrial complex, Mitsubishi Shoji Kaisha, stated that

> The steel mills in Japan are very much interested to make a contract [for Canadian coking coal] on a long term basis if there is no fear that the price may be raised in case the [federal rail] subvention is withdrawn entirely or partially.[53]

Importance of guaranteed subventions is indicated by the fact that the government has now assured the industry that they will continue for at least five years.

C. Rationalization of Rail Transport.

The coal operators are satisfied with this present situation but ultimately would like to be free of dependency on the subsidy. They still pay what they feel are unreasonably high freight rates. There being no practicable alternative means of long distance transport, the mining companies have little choice but to use the railroads and pay at the rates demanded. The coal operators do have several legitimate complaints. They rightly feel that they are entitled to

---

[52]Canada, op. cit., p. 596

[53]Hiro Minagawa, "Japanese Markets for Canadian Minerals", Western Miner, November 1960, p. 36.

some reduced rate if they ship in quantity between two specified points. At present the rate remains unchanged whether one car or an entire trainload is involved. Similarly the rates are the same whether one destination or fifty is involved. Obviously a railroad's costs are less if they can move an entire trainload between points "A" and "B" than if they are required to move all the cars in the train to different destinations. The coal operators feel that some of the railways' savings in handling costs should be passed on to them.

Such thinking is the basis of the argument favoring implementation of "unit trains" or "integral trains". The phrases are often used interchangeably but distinct definitions have been put forward.[54] A unit train uses conventional equipment, with the only improvements being due to better organization. An integral train, however, involves the use of completely new and specialized rolling stock and handling facilities.

The basis of operation of either of these types of trains is the organization of all facilities towards the efficient large-scale movement of one type of cargo between two fixed points. A key aspect of the operations involves minimizing the time during which rolling stock remains at termini or is otherwise inactive. The regularity of the operations would facilitate this minimization and greatly reduce handling costs. Too often in the past, mining firms have tied up boxcars for as long as one month at the minehead, in

---

[54] Cowie, op. cit., passim.

effect using the boxcars for coal storage, with the railroads paying the storage costs. On the other hand, the mines have often had difficulty in obtaining cars at all, with resultant increased costs and reduced outputs. Regular efficient operation of unit trains would thus greatly benefit both the mines and the railways.

To this end, talks are now under way between the C.P.R. and representatives of Coleman Collieries and Canmore Mines with a view to initiating the use of unit trains. Preliminary studies indicate that the present average turn-around time could be reduced from twenty days to seven. This increased efficiency would possibly permit the reduction of rail shipping costs from the Alberta mining centers to the Port Moody docks by about $1.80 per ton.

D. The Coal-fired Gas Turbine.

Should the talks on unit trains bear fruit, the close relationship of the coal industry and the railways will be re-inforced. Yet the interdependency will never be as marked as it was in the days before dieselization when the railway locomotives themselves depended upon coal as a fuel. For a time in the 1950s there was great optimism in the coal industry that a new type of locomotive would displace the diesel, and coal would again be the premier locomotive fuel. The project which stimulated this optimism concerned the development of a coal-fired gas turbine by Professor Donald Mordell of McGill University. The research program was heartily encouraged by the Dominion Coal Board. Donald Gordon, head of the C.N.R., spoke in 1951 of the ". . . intriguing possibilities in the gas-turbine locomotive which offers certain economies not available in the diesel."[55]

---

[55]"Coal Opens New Fuel Vistas", Western Miner, April 1951, p. 184.

These economies included lower costs for both fuel and maintenance. Mordell himself was very confident of the project. "Considering the railway application it seems indisputable to the writer that the gas turbine is going to receive wide adoption."[56]

It is now generally conceded, however, that the coal-fired gas turbine is not suited to use in railway locomotives, being simply too heavy to be adapted efficiently to motive power. Work is continuing, however, to attempt to apply the turbine to stationary power generation. It appears that it is most efficient in the range of 30,000 kilowatt generating units, very small when compared with present trends in Canada and the U.S. Therefore, if this turbine does come into commercial use, it will likely serve only peaking requirements, and thus would not be a major coal consumer.

Hence there is little prospect that coal will again be a major source of locomotive fuel in the foreseeable future. The old intimate interdependency between the railways and the coal industry remains only historical. The railways are still vital to the mines however, and in some cases, such as the projected railroad from Hinton to the Peace River Country, the importance of coal and the railways to regional development is still in evidence. It is thus still true that one cannot adequately explain the coal industry of Alberta without dealing at some length with the railways.

---

[56]Donald Mordell, "Present Position and Prospects of the Coal Burning Gas Turbine", Transactions of the Canadian Institute of Mining and Metallurgy, vol. 55, 1952, p. 77.

CHAPTER III

INDUSTRIAL STRUCTURE AND THE TECHNOLOGY OF COAL PRODUCTION

In this age of rapid technological advances, production techniques in most industries have changed and are changing greatly. At times the coal industry seems to have lagged in this progression towards technologically more advanced methods. To some extent this lag was almost inevitable since coal, as one of the earliest large industries in Alberta , was subject to industrial inertia. Heavy investment in capital equipment and in given locations meant that many companies were forced to continue to operate with obsolete equipment or in unfavorable locations. Today, however, the coal industry in Alberta is generally speaking making use of the most modern production techniques available. This condition is in turn reflected in the much healthier state of the industry compared to that of a decade ago.

I. The Scale of Operations.

Some of the most significant changes in the Alberta coal industry have concerned scale of operations. Throughout most of its history, the industry has been characterized by a small number of large, progressive, and economically viable operations, plus a very large number of small scale operations using marginal techniques and having extremely limited life spans. This plethora of small mines long constituted a major problem for the industry. Only rarely were these operators capable of any significant capital accumulation necessary for investment in new plant. The industry was thus long characterized by a large number of mines whose common features were

financial instability, poor equipment, inefficient techniques, small, fluctuating outputs, small, poorly paid work forces, and uncertain futures. This condition would have been undesirable even if the only people adversely affected were those directly involved in the small-scale operations. However too often the whole industry suffered since some of these mines, known as "snow-birds" or "bootleg mines", were operated illegally without licences, damaging the name of the entire coal industry. Also, with their overhead costs being extremely low, the "bootleggers" were often able to market their product at prices below the general industry levels. Then typically the "mine" would be abandoned within months, after having reduced the markets of other operators trying to establish themselves on a solid, long-term basis.

Some statistics will illustrate how numerous these small mines were in the early decades of this century. Dowling noted there were twenty-four producers of sub-bituminous coal in the Edmonton district in 1907. Of these the one with the single greatest output was the Standard Mine with a tonnage of 21,200 tons.[1]

By the mid-1920s the situation had not improved. The Evans Commission of 1925 reported that of 362 mines operating in Alberta in 1923, 293 of them accounted for only 4.6 per cent of the total provincial output. The average output of the mines in this category was less than eleven hundred tons in the entire year.[2] In contrast,

---

[1]D. B. Dowling, "Steam Coal of the Cascade Basin. Lignite Areas of Alberta and Saskatchewan. Production of Coal in Alberta and Saskatchewan", Summary Report, G.S.C., 1908, p. 81.

[2]Alberta, Report of the Alberta Coal Commission, 1925, Edmonton, 1926, p. 332.

twenty mines accounted for two-thirds of the province's output, with production of more than 100,000 tons each.

Under such conditions it is hardly surprising that one of the greatest problems facing the industry at that time was over-capacity and over-production. Little initial capital outlay was required to establish small-scale operations in order to take advantage of temporarily favorable economic conditions. Many of these "mines" consisted merely of small outcrops worked by farmers in their spare time. Then when the favorable economic conditions ceased to exist, in many cases so did the mines. The number of mines abandoned in any one year was commonly as high as fifty, and in 1923 and 1924, the combined total for abandoned mines was 174.[3] Many of these mines were later worked again by a different operator but usually the ultimate result was again abandonment.

The great number of small mines with consequent over-capacity and over-production was recognized by the 1925 Evans Commission as one of the industry's most serious problems. The chaotic situation had serious repercussions in the field of labor, with many areas having a surplus of mine labor the year round. The basic problem was over-development--". . . too many mines and too many miners--the great expansion of the market simply meant irregular employment for more miners."[4] Even the appearance of much more efficiently organized

---

[3] Ibid., p. 41.

[4] Ibid., p. 183.

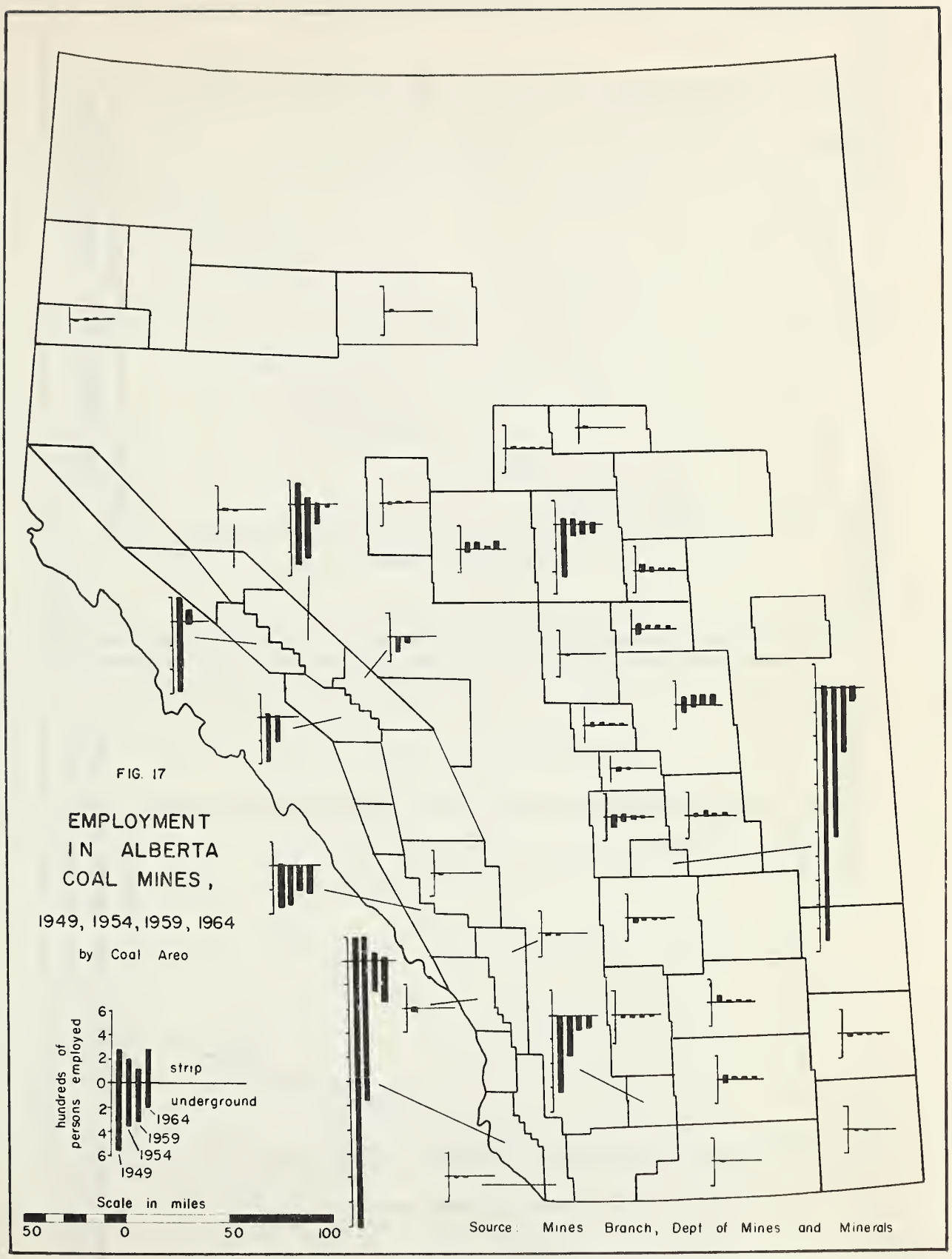


FIG. 17
EMPLOYMENT IN ALBERTA COAL MINES,
1949, 1954, 1959, 1964
by Coal Areo
hundreds of persons employed
6
4
2
0
2
4
6
strip
underground
1964
1959
1954
1949
Scale in miles
50
0
50
100
Source: Mines Branch, Dept of Mines and Minerals

EMPLOYMENT IN ALBERTA COAL MINES, 1906 - 1964
oil mines
strip mines only
THOUSANDS OF PERSONS EMPLOYED
0
1
2
3
4
5
6
7
8
9
10
11
1906
1916
1926
1936
1946
1956
1964
YEARS
Source Mines Branch,
Department of Mines and Minerals

a)

COAL PRODUCTION IN ALBERTA, 1906-1964
Total production
Strip production only
MILLIONS OF TONS
0
1
2
3
4
5
6
7
8
9
1906
1916
1926
1936
1946
1956
1964
YEARS
Strip production statistics
unavailable prior to 1922
Source Mines Branch,
Department of Mines and Minerals

b)

Fig. 18

competitors failed to stimulate the coal industry into economic rationalization. The arrival of natural gas in Edmonton in 1923 led to surprisingly little consolidation of operations in the coal-fields of Edmonton and district.

In an attempt to counter over-development, the Evans Commission proposed a more strict control of leases and licences. Obviously no solution was obtained since the same recommendations were made by the Barlow Commission ten years later. The latter recommended that mineral leases to operate new mines be refused for five years. It was even recommended that holders of existing leases be encouraged by tax concessions and other measures to suspend operations for five years at which time the market would be reviewed. The Commission's final recommendation was actually more a plea, since it involved no specific measures by which the aims might be achieved. It was a plea for rationalization of the industry, for closure of marginal mines, amalgamation of viable firms, and concentration of economic activity at the sites and in the situations where conditions were most favorable.

The plea went largely unheeded, however, and when the federal Royal Commission of 1945 was called, it noted the same chaotic conditions in Alberta's coal industry. As ever, the industry was dominated by a few producing areas, but plagued by numerous marginal operations as well. In 1944 two of Alberta's fifty coal areas accounted for 49 per cent of the provincial output. These were Crowsnest with 26 per cent and Drumheller with 23 per cent. Even in these areas,

however, the small inefficient operations were a common part of the economic scene, resulting in needless duplication of equipment. The Drumheller area at that time had twenty-three mines, ten of which produced 90 per cent of the district's output.[5] Edmonton, another leading district, was also still characterized by a large number of small firms with twenty-one of its twenty-six mines accounting for only 36 per cent of the area's output in 1944.[6]

This abundance of small mines was always much more marked on the plains than in the mountains. There were several reasons for this. Many of the plains mines were operated by farmers. Farmers, and a population to absorb the output of their mines, were far more numerous on the plains than in regions like the Coal Branch. On the plains, coal mines were often simply a side-line. If they were successful it meant added cash income. If they failed, it rarely meant total economic disaster for the operator.

In the mountain districts, however, the situation was entirely different. Often the coal mines were not merely the major source of income, but the only source of income. Coal mining here was no sideline, but a vitally important industry for entire communities. Mining here was much more highly organized not only in individual mines, but between the steam coal operators, who recognized that many of their problems were common and might be overcome through common

---

[5]Canada, Report of the Royal Commission on Coal, 1946, Ottawa, 1947, p. 108.

[6]Loc. cit.

discussion and effort. Domestic coal operators have rarely had such formal organizations. The one notable exception is the Drumheller Coal Operators' Association, established in 1944.

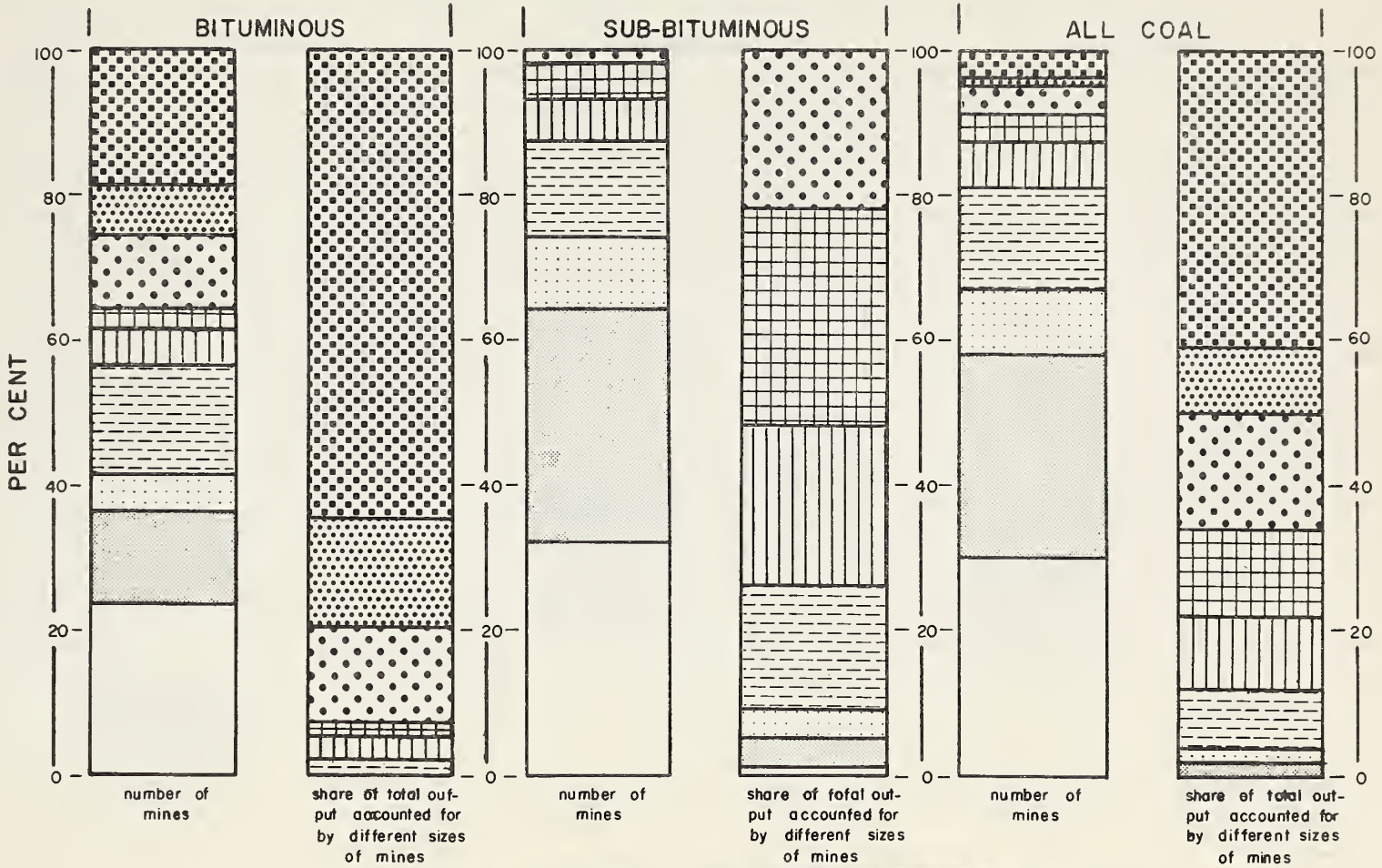
The character of the industry remained largely unchanged through 1949 (see Fig. 19). Since that time momentous changes have occurred in the industry (see Fig. 20). Two of the largest coal markets, the supply of fuel to railroad locomotives and to domestic households, have collapsed. Also great changes have occurred in production techniques, most notably in the much more important role played by stripping. One result of the changes has been a rapid decline in the number of operating mines to fifty in 1964 (see Figs. 21, 22, 23). The number of persons employed in mines has also decreased but at a slower rate indicating that some rationalization has occurred (see Fig. 17).

However the mine closures have by no means all been of a desirable nature. Certainly many of those which were abandoned were small, inefficient, irregular producers whose only effects on the industry were disruptive. But there have been other closures too, which have included some of the largest and most consistent producers such as Mountain Park, Cadomin, West Canadian Collieries at Blairmore, and several major mines in the Drumheller district. The statistics shown in Table VIII indicate that it is not only the small scale operators who have been forced to cease operations.

Despite the closure of some of its largest mines, Alberta's coal industry is now in a relatively healthy state. This was noted

FIG 19

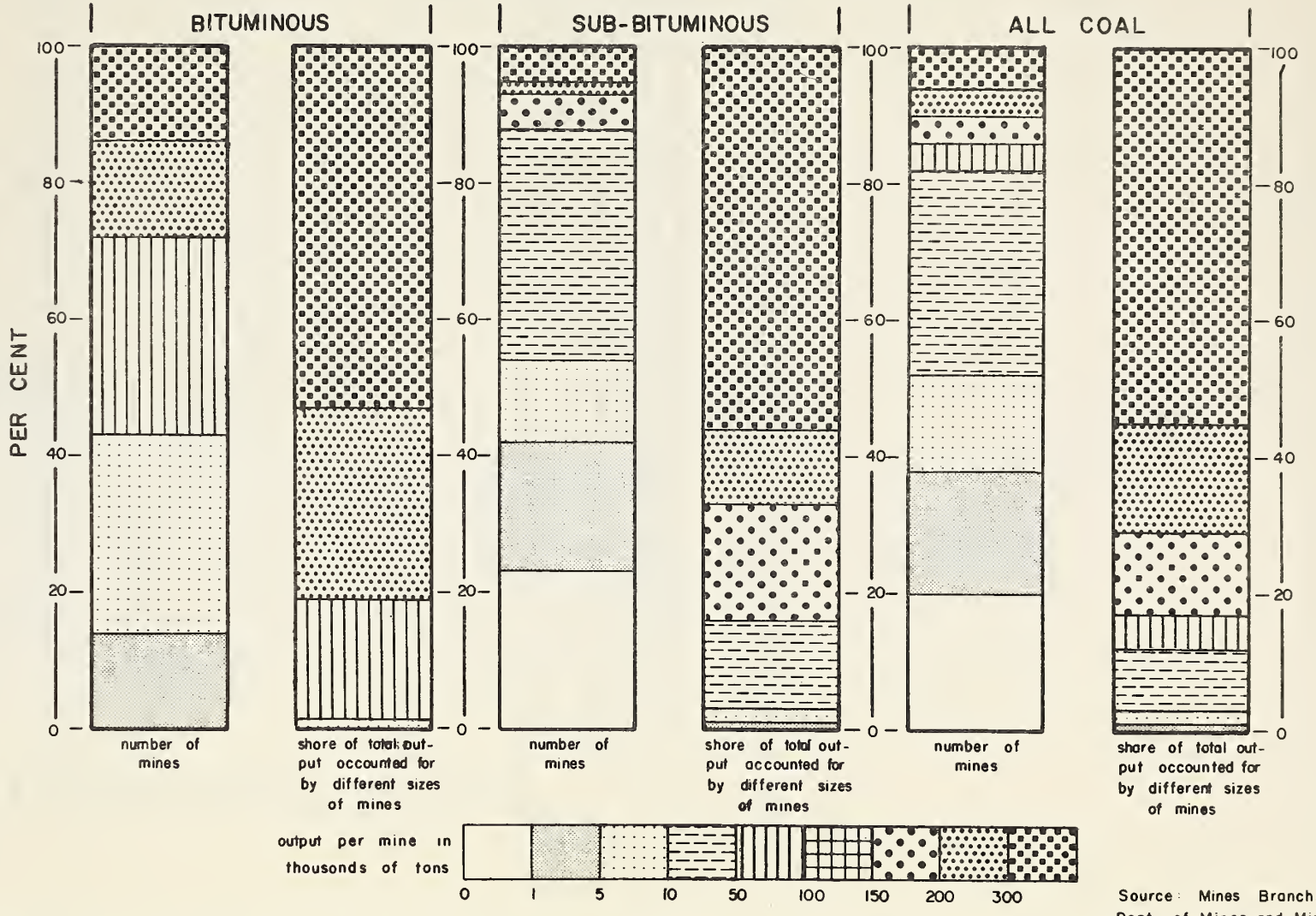
NUMBER OF PRODUCING MINES AND OUTPUT BY SIZE OF MINE, 1949



Source: Mines Branch, Dept. of Mines and Minerals

FIG. 20

NUMBER OF PRODUCING MINES AND OUTPUT BY SIZE OF MINE, 1964



Source: Mines Branch, Dept. of Mines and Minerals

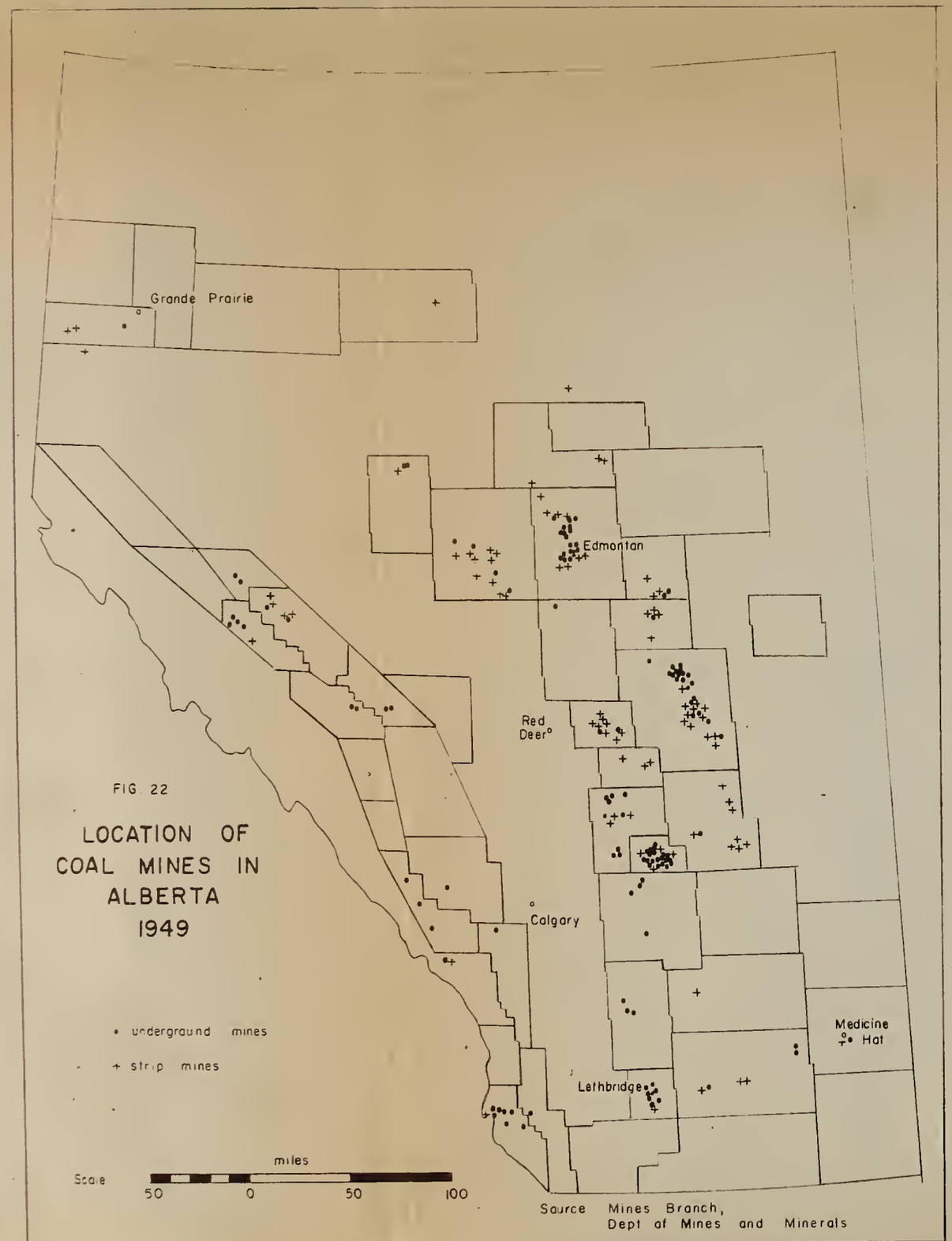


FIG. 22

LOCATION OF COAL MINES IN ALBERTA 1949

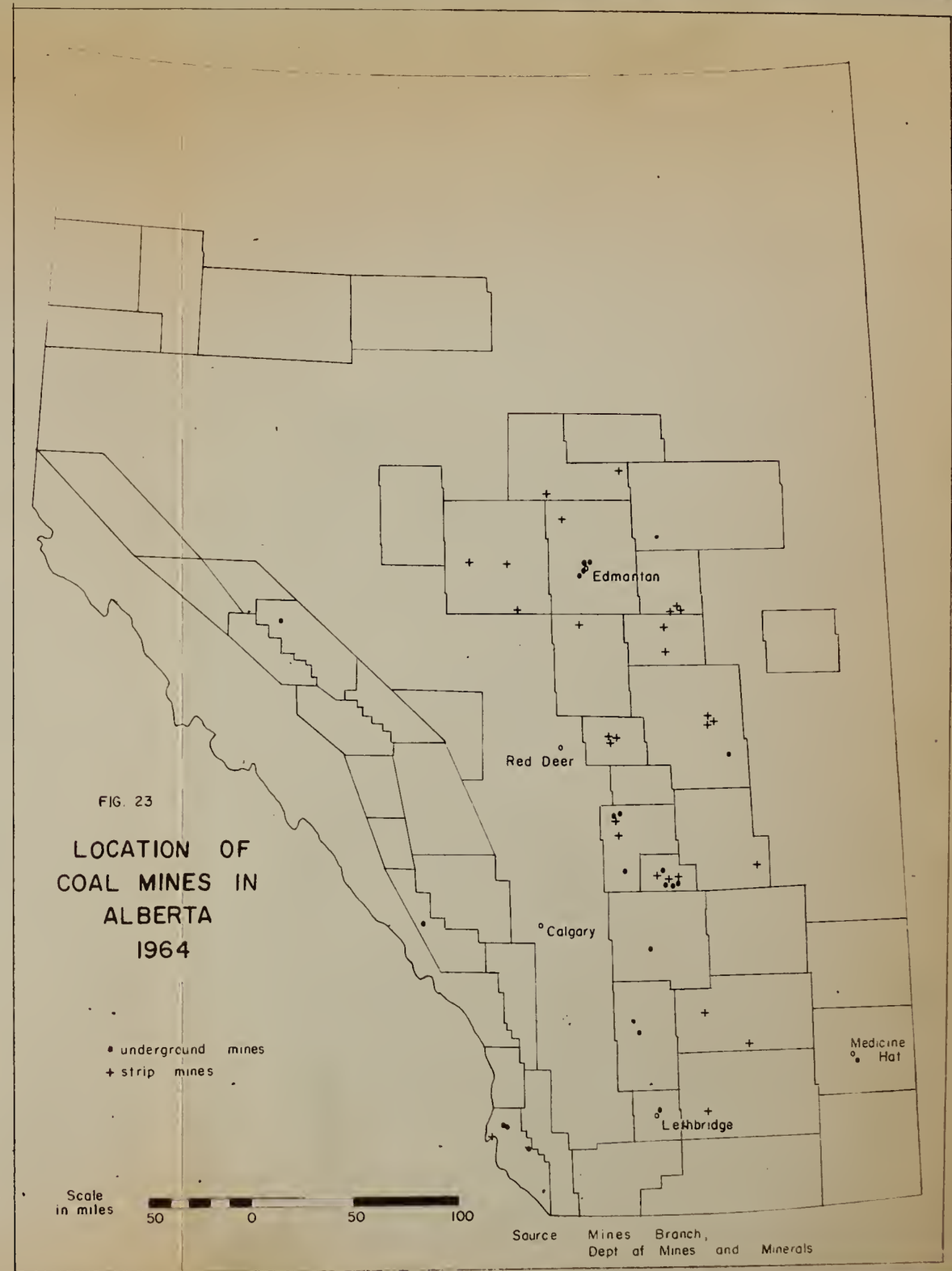


FIG. 23

LOCATION OF COAL MINES IN ALBERTA 1964

TABLE VIII [7]

CLASSIFICATION OF ALBERTA COAL MINES BY TONNAGE, SELECTED YEARS, 1949-1964.

	under 10,000 tons	10,000 - 100,000 tons	100,000 - 200,000 tons	over 200,000 tons
1949	137	40	17	11
1952	97	37	12	11
1955	74	27	8	7
1958	51	23	6	3
1961	38	19	4	3
1964	26	17	2	5

[7]Alberta, Dept. of Mines and Minerals, Annual Reports: Mines Branch.

by John Davis in his study for the 1957 Royal Commission on Canada's Economic Prospects.

> Capable of raising large amounts of capital for forward development and at the same time geared to demands which are more predictable, more specific as to reality and less subject to displacement by other fuels, it is assuming a structure which is corporately and financially quite different from that which characterized coal production and marketing up to the outbreak of World War II.[8]

Probably the best example of the new look of Alberta's coal industry with respect to scale of operations and financial backing is the Whitewood Mine at Wabamun, owned by Calgary Power Limited and operated by Alberta Coal Limited, a subsidiary of the Mannix industrial complex. The operations illustrate the stability of a captive mine (i.e., one that is consumer owned, in that virtually all production is consumed by the owner, Calgary Power). The arrangement permits the facilities to be operated at almost full capacity.

Wabamun is a large scale strip operation, with output now about 1,000,000 tons per year with a work force of just sixty men.[9] This compares very favorably with large scale strip operations in the United States. Wabamun's annual output is expected to increase to nearly 2,300,000 tons in 1970.[10]

---

[8]Davis, op. cit., p. 69.

[9]Pers. comm., H. F. Bish, Wabamun, September 7, 1965.

[10]Pers. comm., T. D. Stanley, Calgary, Aug. 19, 1965.

The Whitewood Mine had the advantage of being a large-scale efficient undertaking from its inception. Natural gas rather than coal was used at Calgary Power's Wabamun Station in its early stages. Thus it was not necessary to begin mining operations on a small inefficient scale, gradually increasing efficiency and scale as electrical load requirements grew. Mining was not begun until the demands of the power plant were for 600,000 tons per year, permitting an economic, large-scale operation from the beginning. Whitewood Mine is representative of the present trend in Alberta's coal industry towards concentration of production at a small number of favorable sites. The small mines have declined greatly in number and importance (see Fig. 21).

II. Mechanization of Mining.

A. The Financial Barrier.

One of the main stimuli responsible for producing this change has been the increasing importance of mechanized mining techniques. By the 1930s the steam coal mines, or bituminous mines of the mountains, generally had good, well-maintained equipment. The situation was much different among many of the domestic mines of the plains which were often poorly equipped. The Barlow Commission of 1935 reported that they imparted ". . . an appearance of tawdry impermanence. . . ."[11] The appearance was genuine in that many of these mines were impermanent--small-scale operations lasting only a few years or possibly but a single winter season. Obviously such mines lacked the capacity

---

[11]Alberta, Report of the Royal Commission Respecting the Coal Industry of the Province of Alberta, 1935, Edmonton, 1936, p. 17.

for capital accumulation necessary before investment in mechanized techniques was possible. Costs of machinery were very high partly due to the relatively small market existent in Canada and the consequent lack of Canadian producers of the machinery needed. Hence it was necessary to import most of the machinery at great cost. "During the war [World War II] the cost of mining machinery to Canadian mines was fifty per cent higher than to United States mines."[12] Obviously this cost barrier delayed mechanization of Alberta mines considerably, and was responsible for keeping down productivity levels in some of Alberta's leading domestic coal areas such as Drumheller.

B. Physical Barriers.

Physical conditions as well as economic ones also delayed mechanization of Alberta's mines. The steeply pitching seams of the bituminous mines have long been recognized as a major problem. Most of the machinery responsible for the high productivity rates achieved in the Appalachian mines of the United States has been developed specifically for use in the relatively flat-lying seams of that region and cannot be adapted to the pitching seams of Alberta. Moreover much of the success of the American coal industry is due to the development of "unit" mining, whereby mechanized cutting, advanced drilling and blasting techniques, mechanical loading, and mechanical haulage are all integrated into one efficient unit.

---

[12] V. A. Cooney, "The Greatness of Coal", Western Miner, vol. 21, no. 9, September 1948, p. 62.

Mobility is a factor of prime importance. All parts of the unit must lend themselves to being moved into position and used at the optimum time. However mobility is much reduced in the pitching seams.

Too often in the past, Alberta operators have seemed resigned to accept the idea that pitching seams necessarily remove all possibility of mechanized loading. One operator of a mine on the Coal Branch noted the existence of pitching seams in 1948. "Although mechanized mining is thereby eliminated the necessity does not arise. The method of working rooms has stood the test of time and has proved satisfactory under the natural conditions prevailing."[13] Such conservatism was unfortunately not uncommon at that time, particularly at mines whose capital backing was far from the actual scene of operations, as in the U.K., France, and Belgium. Significantly, perhaps, the mine referred to above is no longer operating.

Other operators have invested much time and money in the development of mechanical loading systems suitable for Alberta mountain conditions. The duckbill shaker conveyor systems have been used very effectively by Canmore Mines with outputs of twenty-five tons per manday being achieved on slopes up to 22°.[14] These systems carry coal from the face to bucket scrapers which in turn move the coal to the haulage levels. West Canadian Collieries at Blairmore used the duckbill system as early as 1947. However, though it

---

[13]L. G. Chavignaud, "Mercoal Mine Has Extensive Reserves of Quality Coal", Western Miner, vol. 21, no. 8, August 1948, p. 69.

[14]A. Ignatieff, A. Brown, and F. L. Casey, "Conditions and Occurrences in the Canadian Coal Mining Industry", Canadian Mining Journal, vol. 72, no. 10, October 1951, p. 70.

resulted in increased overall efficiency, it was not used in producing coal per se, but in the construction of entries and haulage ways. The average dip at the Greenhill Mine of West Canadian was about 40°.

Other physical barriers to mechanization result from the intense folding and faulting which has occurred in the Lower Cretaceous coal measures. Excessive gas is often encountered, particularly at great depths, which makes the use of electrical equipment somewhat hazardous. The risk of a "bump" is also much greater at increased depths.

Even in the plains region where the seams are flat-lying difficulties are encountered in using mechanical loaders. Often the composition of the overlying strata is such that the stability of the roof is inadequate. Moreover many of the sub-bituminous coals of the plains are so soft and friable that machine loading causes excessive breakage. This is especially critical if a significant portion of the output is marketed as lump coal for use as domestic fuel.

One of the reasons for the most recent advances in American mining is the increasingly widespread use of continuous mining. This mechanized technique permits more complete recovery from any given area, and therefore the concentration of mining activity at fewer faces which is more efficient. Continuous mining is also safer because the need for blasting is eliminated. However, without blasting, very hard coals are difficult to work. Here the friable coals of the Lower Cretaceous prove very adaptable to this type of mining.

Again the pitching seams are a problem, with a dip of 18° being considered the maximum in American circles. Yet one Crowsnest Pass mine has used continuous miners regularly since 1961 in seams pitching up to 25° and in some cases even 35°.[15] Coleman Collieries is presently engaged in a mechanization program at their Vicary Mine whereby continuous miners will be used in sections where the pitch ranges from 12° to 18°.[16]

C. Advances During and Since World War II.

World War II was a turning point in Alberta's coal industry. The industrial boom created great demand for coal. Yet at the same time, with so many young men in the military services, skilled labor was at a premium. Despite the financial and physical barriers, the coal operators were almost forced into extensive mechanization programs. Many difficulties were encountered since any large-scale conversion requires skilled labor to minimize the almost inevitable interruption of production.

Mechanization in the bituminous mines was not a new development. Most of these mines were large-scale operations, with adequate financial backing, and had long been using relatively up-to-date equipment. Even so, the increased pace of improvements in the 1940s was impressive. The Adanac Mine of West Canadian Collieries was one of the first in Alberta to use mechanical loaders. Mechanical cutters,

---

[15]J. E. Morris, "Developments in Steep Seam Mining", Proc., Sixteenth Dominion-Provincial Conference on Coal, Lake Louise, Sept. 3-4, 1964, pp. 149, 167.

[16]Pers. comm., R. Upton, Coleman, Aug. 6, 1965.

hoists, and duckbill conveyors were all in use by 1947. The same firm was also one of only four in the province which was using diesel locomotives for underground haulage by 1951. The Adanac Mine, five miles south of Bellevue, had the advantage of an average pitch of only 10° (see Fig. 7).

The mechanization of the plains coal mines, stimulated by World War II, was highly significant because until that time, they had been much less mechanized than the mountain mines. Atlas Mine was one of the first in the Drumheller field to convert to mechanized cutters. They were introduced in 1940, but serious labor shortages during the war made it impossible to use them to full advantage. By 1948, however, the Atlas Mine and the Commander Mine, both operated by Century Coals Limited, were fully mechanized with respect to cutting and hauling. Mechanical loaders were also used extensively. Today Amalgamated Coals of East Coulee, to some extent a successor of Century Coals, has its entire output machine cut and loaded. It is the leading plains producer in degree of mechanization.

III. Strip Mining.

A. Development of Strip Mining Machines.

Easily the most significant aspect of the stimulus given to coal mining by World War II was the upsurge of strip mining. Stripping had been carried on in Alberta since World War I but only at a very limited number of mines, most of which were small-scale. During the 1930s stripping was usually done by horse-drawn scrapers, and was therefore restricted to sites with less than twenty feet of

overburden. One such mine was located on the left bank of the Bow River about twenty-five miles west of Brooks (see Fig. 2).

The factor of overburden thickness is basic to the success of strip mining. A certain thickness is desirable to prevent the coal beneath it from being too badly weathered. This desirable thickness varies depending upon the composition of the surficial deposits but twelve to fifteen feet is usually thought of as an acceptable minimum. On the other hand the overburden must not be so thick or so hard that it becomes economically unfeasible to remove it to bare the coal seam. Obviously one factor which delayed the advent of large-scale stripping operations was the level of technology. While the stripping of overburden depended upon horse-drawn scrapers, this type of mining remained relatively insignificant.

With the onset of World War II, coal became a strategic material of great importance in maintaining Canada's industries which played such a significant role in the allied war effort. To ensure that the vital coal output would be maintained, the federal government took over and operated a number of Alberta strip operations which would have been economically unfeasible and abandoned under normal peacetime conditions. The strip mines on the Bow west of Brooks were among those operated by the Dominion Fuel Controller.

Even more important for the stripping industry was the general impetus given to technology by the war. The techniques developed out of necessity to produce the needed war materiel could be adapted to the production of large trucks, tractors, shovels,

graders, and excavators. The removal of increasingly greater thicknesses of overburden became more and more efficient. The trend has continued unabated since the end of the war. The early strip shovels used for recovery of the coal itself had average capacities of 2.5 to 3.5 cubic yards before 1920. By 1956, shovels of sixty to seventy cubic yards were commonplace in the United States. The rapidity of change is indicated by the fact that by 1959 capacity had again doubled, with 115 to 140 cubic yard shovels in common use. Today they exceed 200 cubic yards.[17]

The size of the stripping draglines has shown similarly amazing growth. As recently as four years ago draglines with bucket capacities of thirty to thirty-five cubic yards were standard. Now buckets of 150 cubic yards are being developed. These advances have made it necessary to re-evaluate coal deposits. Only a few years ago, fifty feet of overburden was considered the maximum for economic feasibility. Now 150 feet is being considered.

Facilities for hauling coal from the strip pits to the tipple are also much improved. American mines which utilized horse-drawn carts in the 1920s now use trucks of ninety ton capacity. Those used at the Whitewood Mine in Wabamun have capacities of slightly more than fifty tons.

Major technological barriers have thus been hurdled. Adequate machinery is now available for strip mining if suitable

---

[17] T. G. Gerow, "The Strip Mine of the Future", Proc., Sixteenth Dominion-Provincial Conference on Coal, Lake Louise, Sept. 3-4, 1964, p. 140.

Bucyrus-Erie Company, History of Development of Strip Mining Machines, South Milwaukee, Wisconsin, 1964, p. 16.

physical conditions prevail. Most important of these is a reserve of coal which is large enough to justify the capital outlays necessary to procure the costly machinery required if the operation is to be efficient.

B. Physical Conditions.

1. The Strip Ratio. The strip ratio must also be favorable. Here the extent of overburden which must be removed is compared with the extent of recoverable coal. For example it may be given in cubic yards of overburden per cubic yard of recoverable coal or in feet of overburden per foot of recoverable coal. In the Tofield Coal Area a seam five to eight feet thick is overlain by less than thirty feet of overburden. This is a very favorable strip ratio.

Conditions at the Whitewood Mine illustrate two aspects of the strip ratio. The coal seams dip to the southwest at about thirty-five feet per mile, which means that the ratio becomes more unfavorable as one moves in that direction. Occurrence of coal in more than one seam is economically significant. Multiseam mining, as is necessary at Wabamun, is more costly since each seam must be bared and cleaned separately if the partings between them are excessively wide. Therefore the strip ratio must be more favorable under these conditions if the total operation is to be as economically attractive as that of a site with a similar strip ratio, but one in which all the coal is concentrated in one seam.

2. Drainage. Drainage conditions can have a significant effect on the overall costs of strip mining. A high water table and near saturated seams necessitate costly pumping procedures to enable

the large pieces of machinery to operate effectively. The Whitewood Mine has the unfortunate distinction of having to contend with a drainage problem unique to large strip coal mines on this continent due to the occurrence in the area of muskeg.

3. Slope. Excluding the presence or absence of coal itself, the physical condition most important in determining the feasibility of a strip mine is the slope of the terrain. Obviously the large pieces of machinery such as walking draglines and electric shovels are best suited, if not completely restricted, to relatively flat surface terrain and flat-lying coal seams. Such conditions are dominant in the plains region where the sub-bituminous coals occur. Even on the plains, however, local difficulties arise. For example the regional dip of strata in the Wabamun Coalfield is a very favorable one per cent. Yet local dips of 15 per cent and even 30 per cent do occur and add to mining costs.

The rolling terrain of the foothills makes it impossible to utilize the most economical stripping equipment such as the large capacity shovels and draglines. Hence, if stripping is carried on in this region, more versatile, less specialized, and therefore less economical machinery such as standard caterpillar tractors must be used.

Strip-mining in the mountainous terrain where the Lower Cretaceous deposits occur is naturally very difficult, given the prevalence of steep surficial slopes and steeply pitching sub-surface strata. It is possible, however, if local conditions are unusually

favorable. An example would be the case where the slope of the terrain and the pitch of the seam approximately coincide. Even under the best of conditions, however, production costs of strip mines in the mountains are commonly three times greater than those of the plains mines.[18] The mountain mines have one big advantage in that their coal is one of high calorific value, generally at least 12,000 B.T.U. per pound. This compares with an average of about 8,500 B.T.U. per pound for plains coals. The difference in heat value, however, is not nearly great enough to compensate for the higher production costs encountered in the mountains.

C. Development of Strip Mining in Alberta.

Given this set of circumstances one would expect to find most of Alberta's strip mines on the plains. Until World War II, this was certainly the case. In 1944, 90 per cent of the province's strip mines were in the plains region. The principal operations were in the Tofield, Brooks, Taber, Sheerness, Camrose, and Castor Coal Areas (see Fig. 3).

However during and immediately after the war a great change occurred within the bituminous coal industry. In 1940 there had been no bituminous coal produced by strip mining techniques. By 1947, 22 per cent of the bituminous output was obtained in this manner and by 1950 this figure had increased to more than 65 per cent.

The change was prompted by several factors. Many of the large bituminous mines were in difficult straits during the war. Most of

---

[18] Pers. comm., J. G. MacGregor, Edmonton, March 2, 1965.

their problems revolved around labor. There was a serious shortage of mine labor during the war due to the demands of the military services and other burgeoning industries. Moreover the labor which was available was becoming increasingly more costly. Several of the large and consistent bituminous producers therefore turned to stripping. Whereas underground mining is a labor intensive industry with about 65 per cent of total costs attributable to labor, stripping is capital intensive, with labor accounting for only about 35 per cent of overall costs.[19] This relationship is easily understood when it is realized that the dragline at Wabamun, which can remove 9,000,000 cubic yards of overburden to uncover 2,500,000 tons of coal per year, is operated by one man.[20]

The shift to stripping was facilitated by the ready availability during and after the war of mechanized equipment adaptable to stripping. Cadomin Coal Company was one of the bituminous mines to make the change. Stripping began in 1944 and averaged about 300,000 tons annually for the first four years.[21] Brazeau Collieries at Nordegg began stripping in 1946, with about forty per cent of the total output obtained in this manner. One year later stripping began

---

[19] J. M. Henderson, The Efficiency of the Coal Industry, Cambridge, Mass., 1958, p. 48.

[20] M. M. Williams and C. F. Doerr, Power From Coal at Wabamun, Calgary, 1962, Part II, p. 4.

[21] "A Leading Coal Branch Producer", Western Miner, vol. 21, no. 8, August, 1948, p. 66.

in the province's leading bituminous producing area, the Crowsnest. West Canadian Collieries worked the old Lille property on Grassy Mountain, McGillivray began stripping directly north of their underground operations, and International Coal and Coke worked along York Creek. Finally Hillcrest-Mohawk opened strip pits on Tent Mountain, about fourteen miles southwest of Coleman on the Alberta-B.C. border, and trucked the coal twenty-five miles to their Bellevue tipple (see Fig. 7).

However the shift to stripping failed to save most of the bituminous operations. An official of the Cadomin Coal Company commented in 1948 when his firm was stripping up to seventy-five per cent of its output, that ". . . strip mining, especially in the mountainous regions, lacks the degree of permanence necessary in coal mining. . . ."[22] His statement was well founded. Today only one major strip mine is operating in the mountain region. This is the Tent Mountain mine, now operated by Coleman Collieries. Even this one is regarded as somewhat of a back-up operation to the company's main mine, the underground workings at Vicary Creek.[23] Tent Mountain does have the capacity, however, to produce 1500-1600 tons daily.

Strip mines on the plains have proved to be much more viable operations than those in the mountains. Many small underground mines

---

[22]Ibid., p. 67.

[23]Upton, op. cit.

converted to stripping in the mid-1940s, with most showing marked increases in output and productivity. The Black Nugget Mine at Dodds near Tofield began stripping in 1944 from a seam six to seven feet thick, overlain by 25-35 feet of overburden (see Fig. 2). Within five years annual output had increased more than sixfold to 156,000 tons. Kleenbirn Collieries at Eyremore on the Bow River, twenty-five miles west of Brooks had a similar history (see Fig. 2). The Company had had large underground workings since before 1920. In 1930 it began stripping and soon the underground mine was abandoned.

The success of the strip mines in the late 1940s in many cases meant failure for long established underground mines. At that time the main competition for underground coal for use as a domestic fuel was not natural gas or fuel oil, but strip coal. Lower production costs enabled the strip operators to sell at prices much below those of the underground mines. In 1952 Drumheller underground lump coal sold for $9.55 per ton, whereas strip lump coal sold for less than half this price--$4.50 per ton. There had been more than twenty mines in the immediate area of Drumheller at the end of the war, most of them underground. Many were abandoned in the face of this competition (see Figs. 9, 22, 23).

Even those strip mines were very high-cost operations, however, when compared to some of Alberta's strip mines of 1966 which sell coal for less than $1.50 per ton f.o.b. mine. Two of these are located on opposite sides of the Battle River, south of Forestburg (see Fig. 2). Forestburg Collieries on the left bank works a 4.5-7 foot thick seam which lies beneath 30-70 feet of overburden. Equipment includes two draglines with bucket capacities of thirty and seven cubic yards respectively.

Across the river is the Battle River Coal Company, one of several modern stripping operations of Alberta Coal Limited (see Plate I). The background to the latter's growth indicates the way in which the capital resources supporting Alberta's coal industry have improved.

In the mid-1940s the Mannix Construction Company Limited of Calgary began stripping on a contract basis for several coal companies including Brazeau Collieries, Cadomin Coal Company, and Kananaskis Exploration and Development Company Limited. This arrangement offered to the mining companies an effective means of overcoming the economic obstacles to large-scale stripping, especially the acquisition of costly machinery. Soon Mannix itself was producing significant tonnages of domestic coal. One of the firm's subsidiaries, Alberta Coal Company Limited, began producing and selling coal owned by Camrose Collieries from a strip mine five miles east of Camrose (see Fig. 2). Still another Mannix subsidiary, Alberta Coal Sales Limited, operates the Majestic Mine, a strip operation near Taber (see Fig. 2).

D. Strip Mining at Wabamun.

The largest and most significant mine with which Alberta Coal is associated is Whitewood at Wabamun, with an output much greater than any other mine in the province. The history of mining at this coalfield illustrates well the progression of Alberta's coal industry in the past half-century. It began with the opening of a small underground mine by the Conner Coal Mining Company Limited in 1910. Operations

PLATE I

STRIP MINING IN THE
BATTLE RIVER COALFIELD

Electric shovel extracting coal from bared and cleaned seam.

A dragline stripping off the overburden to bare the coal seam.

Battle River Station of Canadian Utilities Ltd. In 1964 this station consumed 275,000 tons of coal, or about 42 per cent of the combined output of the two adjacent mines.

continued on a sporadic basis under a succession of small firms until 1948. In that year Alberta Coal Company Limited bought out Lakeside Coals and opened a strip mine. Soon afterwards Calgary Power began investigating the Wabamun Coalfield as a possible site for a thermal power station and in 1956 purchased the rights to a reserve of more than 60,000,000 tons of recoverable coal. Three years later a contract was signed whereby Alberta Coal Limited agreed to supply Calgary Power with coal for ten years beginning in 1962.

One of the first requirements before actual mining could begin was a detailed map showing the nature, extent, and conformity of the deposit. This was achieved through the use of aerial photographs and a borehole program, followed by physical and chemical analyses. A map of scale 1:4,800 was then drawn up showing fault lines and other physical phenomena which would affect mechanized mining.

The mine is now in full-scale operation. The walking dragline removes the overburden which averages about thirty-five feet in thickness. The coal seams are then cleaned by bulldozer and power brushes, preparatory to the actual mining of the coal by two power shovels with bucket capacities of $7\frac{1}{2}$ and 5 cubic yards respectively (see Plate II). A fleet of 51-ton Euclid coal-haulers transport the coal to the power plant. Until 1972 the hauling distance will be less than two miles, but eventually it will be four miles or more, as the most easily accessible reserves are exhausted. Moreover as mining continues, the thickness of overburden will increase to about 100 feet.

PLATE II

WABAMUN COALFIELD

This dragline has the capacity to remove 9,000,000 tons of overburden per year, baring 2,500,000 tons of coal

Aerial photograph, 1" = 800 feet.

Wabamun Station, Calgary Power Ltd. Note: a) coal stockpile immediately north of station, b) intake canal from Lake Wabamun coming in at the left, c) discharge canal at the right.

Aerial photograph,
1" = 800 feet

Dragline removing overburden from coal seams.

Though the actual mining is done on a contract basis by Alberta Coal Limited, the mine, dragline, shovels, coal haulers, and coal preparation equipment are all owned by Calgary Power. The overall efficiency of the operation is indicated by the fact that the coal will eventually be mined for about 8¢ per million B.T.U.s, a cost as low as anywhere in the world. The scale is such that annual output is expected to reach 2,500,000 tons in the early 1970s. This figure is nearly equal to the 2,750,000 tons cumulative output over the fifty-two year period that this coalfield was worked before Alberta Coal's contract began in 1962.

As a result of the growth of operations such as those at Wabamun and Battle River, the proportion of Alberta's coal output produced by stripping has grown considerably (see Fig. 18).

IV. Other New Mining Techniques.

A. Hydraulic Mining

Large-scale mechanized stripping is by far the most significant of the coal mining techniques to be recently introduced in Alberta, but it is by no means the only one. One method receiving enthusiastic support from the Research Council of Alberta is hydraulic mining. This involves the use of high pressure water jets to "cut" coal from the seam faces, with the water conducted to the face by directionally drilled pipelines. The coal is then transported to the surface by flume and pipeline.

Hydraulic mining enjoys several advantages over other types of mining. Initial capital costs are relatively low and the basis of

operations comparatively simple. Extension of pipeline haulage facilities is relatively simple, particularly when compared with the difficulties involved in construction of railroad trackage. Hydraulic mining is also a comparatively safe method, with the dangers of gas and dust explosions being considerably reduced.

However there are also disadvantages to hydraulic mining. Recovery rates are quite low. Moreover the method is only applicable under certain geological conditions. Roof and floor strata must be strong enough to eliminate caving.

Despite these disadvantages there has been a good deal of optimism in some quarters concerning the possible future for hydraulic mining in Alberta's mountain region. The great attraction is the high productivity rate which can be achieved via this method. Some estimates of up to one hundred tons per man-shift have been made.[24] Proponents of hydraulic mining point to the advances made in this field in the Soviet Union. In 1959 the Soviet Union's most completely hydromechanized operation reported a productivity rate 58 per cent above that of conventional mines in the same district of the Kuznetsk Basin.[25]

---

[24] Pers. comm., N. Berkowitz, Edmonton, May 17, 1965

[25] A. Brown, "Applications of Hydraulics to Mining", Proc. Thirteenth Dominion-Provincial Coal Research Conference, Toronto, Sept. 14-15, 1961, p. 136

Some of the conditions most favorable for hydraulic mining are present in the Alberta bituminous region. Seams are generally well-fissured permitting easy penetration of the water. Also the coal occurs at reasonably shallow depths, minimizing costs of pumping the coal to the surface. Two other necessities, however, are found in only marginal quantities in the mountain region. Obviously for hydraulic mining, one vital commodity is water. Soviet experience indicates that for every ton of coal mined in this way, 1,000-4,500 gallons of water are required, depending upon seam conditions.[26] Another necessity is an adequate supply of inexpensive power. Water and power are actually closely related. Several bodies recently carried out studies in the Crowsnest Pass to determine the feasibility of establishing a large scale coal-fired power station. Limited availability of water for use as a coolant was a major factor in the negative decisions reached. As a result of these rulings, both water and power continue to be in inadequate supply in the region.

Notwithstanding the difficulties involved, Coleman Collieries has recently completed an expensive program of experimental hydraulic mining in their Vicary Mine. The seams worked are twelve to fifteen feet thick and dip at 35°. The steep pitch, rather than being a problem, is actually an advantage since gravity flow is utilized. Moreover, advanced directional drilling techniques can negotiate quite

---

[26] Ibid., p. 123.

violently folded seams (see a). However faults and discontinuous or offset seams often present nearly unsurmountable obstacles and here hydraulic mining becomes effectively impossible (see b). Yet

the scientists at the Research Council remain confident that hydraulic mining does have a role to play in the future of Alberta's coal industry.[27]

B. Coal Planing.

Another system of mining which is used extensively in continental Europe and increasingly in Britain is coal planing, whereby special machines peel the coal from the face in slices several inches thick. Productivity rates are said to be high and production costs low.[28] It has been stated that coal planing is a practical proposition given the conditions present at Canmore and in the Crowsnest Pass. These include thick seams (six to ten feet), steeply pitching seams, friable coal, and strong roof and floor formations. The Lethbridge and Drumheller fields would be less suited to coal planing due to the

---

[27] Berkowitz, op. cit.

[28] A. Schneider-Paas and H. Osthof, "Modern Longwall Mining Techniques", Proc., Sixteenth Dominion-Provincial Conference on Coal, Lake Louise, Sept. 3-4, 1964, p. 173.

common occurrence of weak strata above and below the coal seams and also because of the harder nature of the coal.[29] As yet this method of mining has not been used anywhere in Alberta.

C. Prospects for the Future.

Mechanization of Alberta's coal industry in the post-war period has been impressive. There is still much room for improvement, however, and the impressive trend is likely to continue for some time to come. It seems certain that more improvements will be technologically possible in the near future. Economic barriers will still exist however. Expansion of mining capacity and the conversion to better technological methods both require great amounts not only of capital but of time. Thus even if investment capital is available, operators may be reluctant to improve their plant. By the time the improved facilities are actually in use, two years may have elapsed and market conditions may have changed considerably. Under these circumstances Coleman Collieries' recent large expenditures on experimental hydraulic mining are especially encouraging, reflecting a confidence in Alberta's coal industry which was non-existent one decade ago.

Mechanization of the mining itself often necessitates further expenditures of capital for preparation of the coal before it is marketed. This is necessary because mechanized mining is unselective in that undesirable material such as shale or ash or sulfur impurities are often recovered with the coal. Coal produced from stripping often

---

[29] Ibid., p. 182.

has an excessively high moisture content and is highly weathered, particularly if the thickness of overburden is slight. A high percentage of fines is also common in coal mined by any mechanical method. This may make cleaning more difficult. However while it was a distinct problem in the past, the cleaning of fines is now quite feasible.

It should therefore be recognized that although mechanization is desirable, it in itself does not mean an end to a mining company's problems, and it certainly provides no assurance of success. Some of Alberta's most progressive firms, who were for years among the leaders in introduction of new techniques and ideas, have in the end been abandoned. West Canadian Collieries at Blairmore is a good example. A more recent example is provided by Lethbridge Collieries. Lethbridge had been an important coal producing district for more than eighty years when this firm began an extensive mechanization program at the area's only surviving mine in 1963. The program at Shaughnessy took nearly two years yet the mine was closed with the changeover barely completed. The Shaughnessy experience is evidence that efficient production alone is not enough to ensure the viable existence of a mine. Just as necessary are adequate markets.

CHAPTER IV

TECHNOLOGICAL CHANGE AND THE MARKETS FOR COAL

The collapse of the railroad market has already been discussed as an integral part of the historical development of the coal industry. The other market which has been of the greatest importance to Alberta's coal industry is the household fuel market. Here too almost total collapse has occurred in the post-war period. Again the market losses have been due to interfuel competition. Technological advances in the production and utilization of competitive fuels have enabled them to capture many markets once held almost exclusively by coal.

The pace of technological change in the coal industry has not been as rapid as that of its competitors. The coal industry is one of comparatively long history in an admittedly young province. It is a traditional industry and one unfortunately subject to industrial inertia. Just as England, initiator of the Industrial Revolution, saw late starters such as Germany and the United States pass her in industrial production in the late nineteenth century, so the coal industry, one of Alberta's first great non-agricultural industries, has seen its markets taken over by late starters. To survive, the coal industry has had to utilize, naturally in modified form, many of the technological methods and concepts introduced by its competitors. The actual mining of the coal has seen significant improvement changes in the past two decades, particularly concerning the increased importance of stripping. Similar advances are also necessary in the utilization of coal in order that it might find markets in the technologically

advanced industries. Otherwise the improved techniques made in the physical recovery of coal will have been in vain, if the markets aimed at use coal in ways which are about to become obsolete.

I. The Household Fuel Market.

Although a lack of adequate markets has been given a great deal of attention in recent years, it is often forgotten that this problem is almost as old as the coal industry itself in Alberta. Lack of markets plagued the industry long before the Leduc oil strike of 1947 gave such a stimulus to competitive fuels. The following statement appeared in the 1935 report of the Barlow Royal Commission: "It cannot be too often repeated that the principal problem before the Alberta coal industry at the moment is too many mines and too few markets."[1]

At that time the household fuel market was of paramount importance to most of Alberta's coal mines. For this market, all ranks of coal are used, though naturally certain properties are desirable. Size is an important characteristic. Large lump coal has a slower ignition rate and slower rate of release of volatile matter, both of which are desirable since the danger of gases entering the room is thereby reduced. A coal which burns with little production of smoke is suited to domestic heating. Finally, other things being equal, a coal with a high heat value, will naturally be preferred.

The coal which traditionally has been considered an excellent domestic fuel is anthracite. It is almost smokeless, has long and

---

[1]Alberta, Report of the Royal Commission Respecting the Coal Industry of the Province of Alberta, 1935, Edmonton, 1936, p. 21.

regular burning characteristics, and has a very high B.T.U. value. Until recently, the dominant household fuel in Ontario, Canada's major fuel market, was Pennsylvania anthracite.

Alberta has never produced any true anthracite although large quantities of semi-anthracite have been mined in the Cascade Coal Area at centers such as the ghost towns of Anthracite and Bankhead, (see Plate III) as well as at the current operations at Canmore (see Plate IV). Although much of this coal was marketed as domestic fuel, it never enjoyed the reputation of Pennsylvania anthracite. This is largely due to the fact that the great orogenic forces associated with the Laramide Revolution have resulted in a coal which is often excessively friable. Therefore some of the plains coals, despite their much lower heat values, have had more success in the household fuel market, due to their relatively low percentage of fines. The widespread sales of "Drumheller lump" provide the best example of this pattern. The premium product of the lone surviving major mine of the Drumheller district continues to be lump coal. More than 60 per cent of Amalgamated Coal's output is greater than two inches in size, and more than 45 per cent is greater than five inches in size.[2] Virtually all of the coal shipped to Ontario by Amalgamated is this premium lump which sells for $10.25 per ton (see Figs. 24 & 25).

A. Seasonality of Operations.

Mines dependent to a significant degree on the household fuel market are faced with several problems. Because demand is

---

[2]Hnatyshyn, op. cit.

FIG 24

DISPOSITION OF ALBERTA COAL

by Coal Area

1949

Tonnage consumed by various markets as a percentage of total sales

Provincial Total

Railroads

Briquettes, Others, Alberta

Manitoba

British Columbia

Saskatchewan

Other symbols used

O - Ontario

U - United States

C - used in coke production

Scale in miles 50 0 50 100

Source: Mines Branch, Dept of Mines and Minerals

FIG 25

DISPOSITION OF ALBERTA COAL

by Coal Area

1964

Tonnage consumed by various markets as a percentage of total sales.

Provincial Total

Alberta, Japan, Manitoba, British Columbia, Saskatchewan

Other symbols used

O - Ontario

U - United States

R - Railroads

C - Used in char production

Bq - Used in briquette production

Ot - Others

Scale in miles 50 0 50

Source: Mines Branch, Dept. of Mines and Minerals

PLATE III

BANKHEAD

BOOM TOWN -- 1906

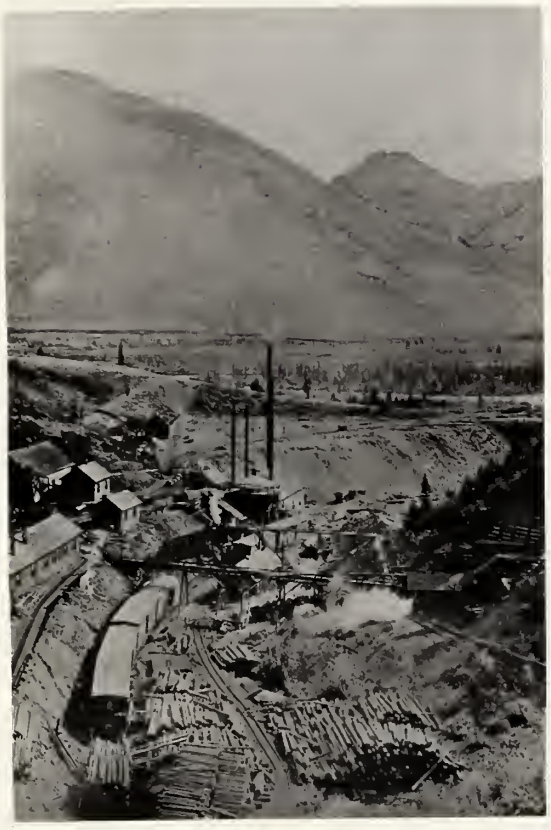
This site is about four miles northeast of Banff. (Source: D. B. Dowling, The Coal Fields of Manitoba, Saskatchewan, Alberta, and Eastern British Columbia, Ottawa, 1909).

Ghost Town -- 1965

PLATE IV

CANMORE

TIPPLE, 1965



Canmore Mines, 1890. (Source D. B. Dowling, The Coal Fields of Manitoba, Saskatchewan, Alberta, and Eastern British Columbia, Ottawa, 1909.)

Preparation Facilities, 1965

naturally much greater in the winter, mine operations are often distinctly seasonal. This problem has been characteristic of the plains mines since their very beginnings and still persists today. Amalgamated Coals of East Coulee runs two shifts per day in the winter and usually has its greatest monthly output in December. In the summer only one shift per day is used and the mine usually shuts down completely for all of July.

The effects of climate and seasonality are also much in evidence in the operations of Subway Coal Company of Rosedale. The annual output of this small firm may vary by more than 60 per cent, depending upon the severity of the winter, since 85 - 90 per cent of the output is sold as household fuel, all within a one hundred mile radius of the mine.

Even for a mine such as Forestburg Collieries where domestic sales account for only about 30 per cent of the total output, operations are still distinctly seasonal. Production during the slowest summer month may well be only 5 - 10 per cent of the output during the peak month in winter.[3]

B. Competitive Fuels.

Although the problems associated with over-dependency upon a seasonal market are serious enough, the situation becomes still worse when even the seasonal market is lost. For decades Alberta domestic coal has faced strong competition. Interfuel competition was originally provided by wood and more recently by fuel oil, propane,

---

[3]Pers. comm., W. Bish, Forestburg, August 20, 1965.

natural gas, and hydro-electric power. In their attempts to win a substantial portion of the Ontario fuel market, Alberta coal operators have also encountered strong competition from other coal suppliers. The latter shipped their product from the northern Appalachians, 1600-1800 miles closer to Ontario than are the Alberta Coalfields (see Fig. 12).

With respect to the household fuel market of western Canada, coal's most serious competition has come from natural gas and fuel oil (see Fig. 26). Natural gas has been used in substantial quantities in Alberta's four largest cities for nearly forty years. Yet in 1941 only seven per cent of all households in the "Prairie Provinces" used this fuel. Hence the large-scale conversion to natural gas and fuel oil has been largely a post-war phenomenon. In February of 1947 the Leduc oil strike gave a great impetus to the oil and gas industry of Alberta. Within six years the number of households heated by natural gas in the four western provinces almost tripled to 245,000 and the number heated by fuel oil increased by more than four times to 260,000. Meanwhile the number of homes heated by coal and coke declined by 135,000, which meant a tonnage loss of nearly 1,600,000 tons.[4] The mines which suffered most were the plains mines of Alberta, Drumheller being a leading example.

The following statement was made in 1951: "Since the beginning of the century, the curve of coal consumption in Canada has not conformed, as in most other countries it has historically

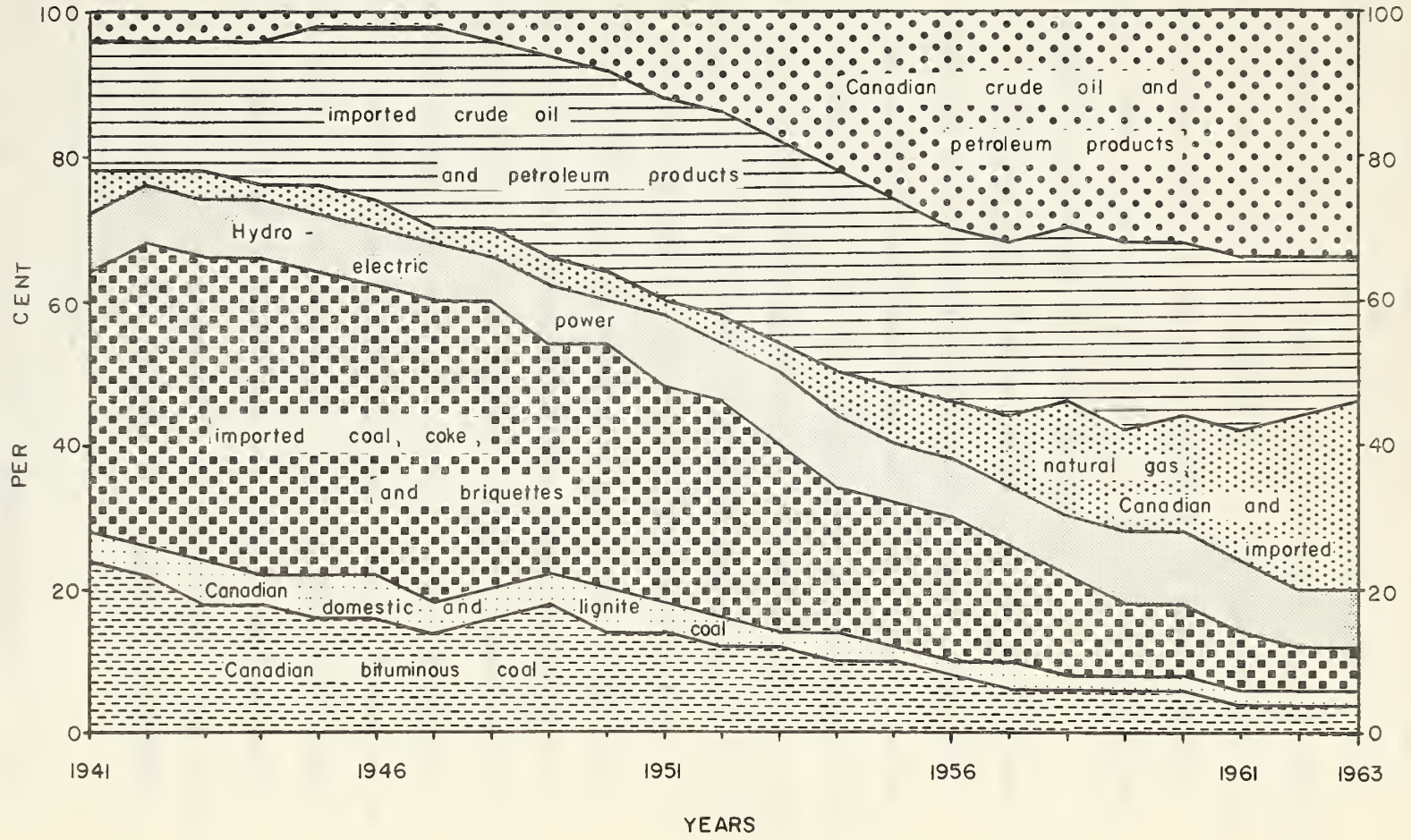
---

[4]Canada, Submission to the Federal Cabinet by a delegation representing District 18 of the United Mine Workers of America, op. cit., pp. 12, 17.

FIG. 26

ENERGY SOURCES in CANADA, 1941-1963

by percentage shares



Source: Dominion Coal Board Annual Report, 1963-1964

conformed, to the growth of Canadian population. This is a very puzzling feature of our national economy."[5] On the contrary this situation is scarcely puzzling at all. The failure of coal production to keep pace with the growth of population and the economy as a whole is due to the inroads made by competitive fuels. A more detailed look at each of these fuels will indicate the extent of the inroads and help to explain the reasons for the conversion.

1. Natural Gas: The use of natural gas as a source of energy in Alberta has a comparatively long history. Edmonton, for example, has had pipeline connections with the Viking-Kinsella fields for over forty years. Yet for a long time gas consumption in the province was comparatively small scale. By 1946 it accounted for only about 25 per cent of the province's energy consumption. Within twelve years over 90 per cent of the homes in Edmonton, Calgary, Medicine Hat, and Lethbridge, were being heated by gas. The many new gas finds in that short period stimulated construction of an intricate pipeline net not only in Alberta itself but over much of populated western Canada. Gas became available to many cities and small towns for the first time. Many industrial plants converted to gas. Canada Cement at Exshaw was one of them (see Fig. 4). Prior to that it had consumed about 90,000 tons of Canmore coal annually.

The reasons for the conversion vary according to the type of consumer. With respect to the domestic fuel market, it is often

---

[5] F. W. Gray, "Canada and Coal", Western Miner, vol. 24, no. 2, Feb. 1951, p. 44.

the home builder rather than the home owner who is the key figure in the choice of a source of space heat. The builder's choice is made on the basis of initial expenditures rather than operating costs. Here gas enjoys a great advantage since its installation costs are relatively small. It is true, however, that thousands of home owners have themselves converted coal furnaces to natural gas. This trend has been aided by a large-scale advertising campaign by gas producers who have been successful in convincing many domestic consumers that gas is the most convenient and cleanest form of home heating.

For industrial consumers, the convenience factor is insignificant. Their choice of fuel depends on cost and efficiency. The efficiency of gas in space heating is about 80 per cent compared with about 48 per cent for bituminous coal.[6] Uniform quality is also of prime importance to industrial consumers. Inability to obtain coal in which the levels of impurities remained reasonably constant was a major factor in the decision of the Canada Cement Company to convert their Exshaw plant to gas.

One very important aspect of Alberta's economy concerns the export of natural gas to the United States. This export program has received considerable encouragement from the provincial government. Consequently the latter has been strongly criticized by representatives of Alberta's coal operators, miners, and coal-mining communities who claim that the gas exports will mean further loss of markets and increased hardships for those dependent on the coal industry.

---

[6]H. H. Landsberg, Resources in America's Future, Baltimore, 1963, p. 187.

The submission of the Joint Crow's Nest Pass Towns Committee to the 1958 Royal Commission on Energy provided a useful antidote to the coal lobby. That submission called upon the commission to recommend export of natural gas through The Pass. The businessmen of the district felt that the gas pipeline, and particularly the proposed processing plants to be built in conjunction with it, would provide a much needed economic stimulus to counter the faltering coal industry. The committee was of the opinion that the gas export program would do much to stimulate diversification of the regional economy, relieving an uncomfortable situation wherein ". . . the Crow's Nest Pass was originally developed, and for the past fifty years has been maintained on an economy based solely on coal-mining."[7] The realistic views of this committee contrast sharply with a 1950 declaration by the Industrial Federation of Labour which viewed the gas export program with "alarm".[8]

The opposition of the coal industry to the gas export program is in a way ironic. Much of the faith which the coal operators have in the future of their industry is based on the widespread belief that the price of gas will rise steeply in the next few years compared with that of coal. Davis for example expects that the well-head price of natural gas will double by the 1980s, while it is anticipated that the average price of coal will show a slight decline over the same period due to improved mining techniques.[9] The price rise in gas

---

[7]Canada, Royal Commission on Energy, submission of the Joint Crow's Nest Pass Towns Committee, 1958, p. 2.

[8]Industrial Federation of Labour, Canadian Congress of Labour, A Declaration on Western Canada Coal, 1950.

[9]Davis, op. cit., p. 62.

will be stimulated by the latter's rapidly expanding markets combined with a tightening resource position. With gas being so readily transportable by pipeline, export sales are expected to play a dominant role in driving up the wellhead price. Hence in opposing the export of natural gas, the coal lobby is opposing a program which will in all probability improve coal's competitive position within Alberta.

The coal operators do have one legitimate complaint, however, against the natural gas distributors. The submission of the Western Canada Fuel Association to the 1959 Royal Commission on Coal included a condemnation of "unfair marketing practices" by some of the gas companies.[10] During the early stages of development of gas distribution systems, the firms involved have on several occasions sold gas at less than cost, often driving coal from long established markets. The gas is dumped into industrial markets at very low prices, with part of the difference being made up by raising the prices charged to household consumers to whom price is not the dominant factor in marketability.

2. Fuel Oil and Propane. Just as natural gas has captured nearly the whole of the household fuel market in the large cities on the prairies, so have fuel oil and propane displaced coal in a large proportion of the small villages and farms. Rural electrification has facilitated the conversion to these petroleum derivatives since the use of automated combustion equipment is then possible.

---

[10]Canada, Royal Commission on Coal (1959), submission of the Western Canada Fuel Association, Calgary, April, 1960.

The net result of the increased use of natural gas, fuel oil, and propane is that coal has lost about 90 per cent of the household fuel market it held in 1945.[11] Today only two large underground domestic mines remain in operation in the entire province. These are Amalgamated Coals at East Coulee and the Star-Key Mine north of Edmonton (see Fig. 23).

The key factor in the shift of household consumers from coal to natural gas, fuel oil, or propane has not been price, but convenience. The latter three fuels are all burned in automated equipment. The need for coal bins, shovels, and removal of ashes has been eliminated. It is worth noting that much of the remaining domestic coal market is comprised of farmers to whom the convenience factor is less significant than it is to the city dweller. Often the farmer picks up the coal from the tipple in his own truck. The only other notable domestic coal markets remaining are in British Columbia where the natural gas pipeline net is not yet as complete as it is on the prairies. Even so, the total amount of Alberta coal sold for use as household fuel is now in the order of only 500,000 tons annually compared with a figure of over 4,500,000 tons in 1950.[12]

C. Coal's Future Position in the Household Fuel Market.

If the coal industry is to regain a substantial portion of the household fuel market, it is essential to make coal more attractive to the urban dweller, i.e., to make it more convenient to use. A considerable amount of research has been carried out by the Research

---

[11] Pers. comm., W. C. Whittaker, Calgary, August 19, 1965.

[12] Ibid.

Council of Alberta and other organizations in an attempt to develop automatic coal stokers and automatic means of ash removal. Some degree of success has been achieved.[13] Probably just as necessary, however, is a massive advertising campaign to educate domestic consumers and to a lesser extent, industrial consumers among whom the belief is widespread that coal is a dirty, inconvenient, and obsolete fuel. Advertising has been very effectively used by distributors of coal's competitive fuels, but it has seldom been used by the coal companies.

The coal operators are currently demonstrating, however, a much greater awareness of both the convenience factor and of advertising and other modern marketing techniques. The "Burn-A-Bag" produced by Alberta Coal Sales' Majestic Mine near Taber (see Fig. 23) attests to the fact that those in the industry are making a strong effort to retain even a small portion of the domestic market. The "Burn-A-Bag" is designed for use in open fireplaces. Sealed ten pound bags of coal are purchased and the burnable bag can be placed directly on the fire. Thus the consumer need not personally handle the coal.

Ultimately it is possible that coal may regain a substantial portion of the home heating market in an indirect manner. A marked trend towards use of electrical heating is expected to strengthen in the next decade. At the present time electrical heating is more expensive than either oil or gas heating. However, those in the coal

---

[13] J. S. C. Dunn and W. A. Lang, Performance of Typical Alberta Coals in a Rotating-Grate Domestic Stoker, Edmonton, 1954.

industry are well aware that price is not the dominant factor in this market. Just as natural gas and oil displaced coal, so safe, convenient, dependable electrical heating in its turn is expected to capture a substantial share of the market now dominated by oil and gas. The trend will be noted first in central Canada where gas is not as cheaply available and where concentrated mass markets justify construction of large-scale and thus efficient thermal power stations. It is expected that in the thirteen year period ending in 1975 the number of electrically heated homes in Ontario will increase by nearly fifty times to 148,000.[14] A large share of this electricity will be generated by coal-fired units. The Lambton Generating Station near Sarnia will have a capacity of 2,000,000 kilowatts by 1971. The even larger Lakeview Station near Toronto will have a capacity of 2,400,000 kilowatts by 1968. The size of the coal market provided just by these two stations can readily be appreciated when it is realized that the Wabamun Station, whose coal-fired units have a present capacity of only 216,000 kilowatts, consumes about 1,140,000 tons of coal annually.[15]

For the moment, however, the amount of Alberta coal used either directly or indirectly for purposes of household heating remains but a small remnant of what it once was. The market area served by the plains or domestic mines of Alberta is especially

---

[14]J. J. Laffen, "Residential Electric Space Heating", Proc., Fourteenth Dominion-Provincial Conference on Coal, Winnipeg, Sept. 13-14, 1962, p. 98.

[15]Pers. comm., H. Laleune, Wabamun, September 7, 1965.

reduced. Between 1911 and 1915, the mines of Drumheller captured the major part of the household fuel market from Winnipeg to Vancouver. Except for a small number of cities, including Edmonton and Calgary which were supplied with natural gas very early, this situation continued until 1947.

Since then the changes wrought by competitive fuels have been immense, as indicated in Table IX.

1. Alberta. The household fuel market in Alberta itself was naturally of considerable importance to the province's coal mines. In the three decades prior to the Leduc strike it accounted for from 1,000,000 to 1,650,000 tons of coal annually. This Alberta demand gave rise to many mines serving very restricted local markets. Often the coal produced was relatively poor in quality, but minimal transport charges enabled the operations to persist. Edmonton, Camrose, and Tofield supported such mines.

2. Saskatchewan. Other districts served much wider market areas. Drumheller is the best example. In 1958 over half of its output was marketed in Saskatchewan, with less than one fifth going to Alberta consumers. Drumheller was not alone in its dependence upon the Saskatchewan domestic market. Until fairly recently 1,000,000 to 1,500,000 tons of Alberta coal were sold there annually and it was not uncommon for the household fuel market in Saskatchewan to absorb more Alberta coal than the corresponding market in Alberta itself (see Figs. 13, 22, & 23). Moreover the Saskatchewan market persisted somewhat longer than that of Alberta. The natural gas pipeline net

TABLE IX[16]

RESIDENTIAL AND COMMERCIAL FUEL
REQUIREMENTS IN THE PRAIRIE PROVINCES
(AS PERCENTAGES OF TOTAL CONSUMPTION)

	1926	1939	1948	1953	1955	Estimates	
						1965	1980
Wood	34	33	28	21	18	13	5
Coal	64	58	52	37	29	18	7
oil	--	5	14	33	43	50	48
natural gas	2	4	6	9	10	19	40
Total	100	100	100	100	100	100	100

[16]Davis, op. cit., p. 302.

in Saskatchewan was not established until some years after similar development had occurred in Alberta. Thus the conversion to natural gas was delayed. Today, however, natural gas is readily available to most Saskatchewan households. This, together with large scale development of that province's own lignite fields, has led to nearly complete disappearance of the Saskatchewan market for Alberta domestic coal producers.

3. Manitoba. Much the same conditions pertain to the domestic market in Manitoba, though quite naturally this more distant province was never as important to Alberta producers as was Saskatchewan. Manitoba sales before 1950 were generally in the range of 250,000 to 500,000 tons per year, or about 10-15 per cent of Alberta's total output.

4. British Columbia. Historically, the amount of Alberta coal marketed as household fuel in British Columbia has been comparatively small, generally ranging from 70,000 to 150,000 tons annually in the pre-war period. Recently B.C. domestic markets have become more important to Alberta producers, at least in a relative sense. Coal has not been as widely displaced in B.C. as it has in the rest of western Canada, since the natural gas pipeline net is less well developed in the rough terrain of that province than on the prairies. Alberta Coal Sales Limited, a subsidiary of Alberta Coal Limited, maintains a wholesale outlet in Vancouver.

5. The World Picture. The post-war pattern which has seen Alberta's coal industry lose a substantial portion of its markets to competitive fuels is not exclusive to Canada. The same development

has occurred in the United States, Britain, France, Belgium, West Germany, and Poland, all of which are major coal producers. Between 1944 and 1958 the coal output of the United States decreased by 223,000,000 tons. Of this loss, 86,000,000 tons were in the household fuel market. It is expected that by the year 2000 no coal will be used for any residential purposes in the United States. The relevant projections made by Hans Landsberg in a study for Resources for the Future are as shown in Table X.

Developments in the production and consumption of coal in Canada have closely paralleled those in the United States for more than fifty years. It is thus reasonable to expect that trends indicated by Table X will also apply to Canada. Direct residential use of coal is expected to be nil in 2000 A.D. However the greatest gains will be made by electricity, much of which will be generated by coal-fired units (see above, p. 117). Thus, indirectly, more coal will be consumed in residential uses in 2000 A.D. than is consumed now. Meanwhile consumption of natural gas may nearly double. This projection would seem to refute the claims of those who assert that the present competitive advantage which natural gas has over coal will persist for only twenty-five to thirty years. The assertion is based on the generally accepted theory that reserves of oil and natural gas are much less abundant than those of coal. Whereas coal reserves are often measured in terms of centuries, oil and gas reserves are measured in decades or even years. Taking into account oil, natural gas, natural gas liquids, tar sands, and oil shales, over 70 per cent of the world's recoverable energy reserve is still in coal.[17] Many economists therefore feel that the tightening resource position of gas and oil will improve coal's marketability

---

[17]Hubbert, op. cit., p. 89.

TABLE X[18]

UNITED STATES CONSUMPTION OF FUELS FOR ALL RESIDENTIAL USES, 1960, AND PROJECTIONS FOR 1980 AND 2000.

	Quadrillion B.T.U.			Percentage of total fuel consumption		
Fuel	1960	1980	2000	1960	1980	2000
Natural gas	3.19	5.66	5.98	35.4	38.9	32.7
oil	2.63	2.09	1.79	29.2	14.4	9.8
Coal	0.53	0.29	----	5.9	2.0	----
liquid petroleum gas	0.28	0.39	0.28	3.1	2.7	1.5
Electricity	2.38	6.11	10.23	26.4	42.0	56.0
Totals	9.01	14.54	18.28	100	100	100

[18]Landsberg, op. cit., p. 199.

within thirty years. The relative inadequacies of supply where natural gas is concerned have also led to the contention from some quarters that its use should be legally prevented in instances where coal could also be used. Such a policy would, for example, reserve large space heating and thermal electric power generation for coal.[19]

To date, however, no such policy has been adopted in Canada. On the contrary, the 1958 federal Royal Commission on Energy recommended that on the basis of Alberta's proven and probable reserves of natural gas, and the projected Canadian demand, controlled export be permitted for at least twenty-five years.[20]

There are also precedents to indicate that even with a tightening resource position, the demand for natural gas will continue to grow steadily. Davis noted in his 1957 study that in Texas demand continued to rise about 8 per cent per year despite a steady rise in well-head price and a local abundance of other fossil fuels. Partly on the basis of these trends, he estimated that per capita consumption of natural gas in Canada would increase 7.5 times between 1955 and 1980 to an annual figure of 75,000 cubic feet.[21]

D. Electricity in Space Heating.

1. Hydro Power and Coal Power. From Table X above, the type of residential space heating which is expected to show the

---

[19]Rank, op. cit., p. 17.

[20]Canada, Royal Commission on Energy, First Report, Ottawa, 1958, pp. 7-8.

[21]Davis, op. cit., p. 171.

greatest increase before the turn of the century, is that dependent upon electricity. Twenty years ago such a projection would have been viewed with alarm by those in the coal industry. The 1945 Alberta submission to the Carroll Royal Commission contained the following statement: "Electrical energy does not yet appear to be a practical substitute for coal for heating purposes."[22] The implication was clear. Should a shift to electrical heating become practical, coal would be in a most disadvantageous position.

However, the past twenty years have witnessed great changes in the field of power generation. When the above statement was made, hydro-power was easily the most economic means of producing electrical energy. Thus a shift from coal heating to electrical heating would have led to the loss of considerable markets for coal. In the interim, however, significant advances have been made in thermal electric power generation. The most inexpensive thermal power produced in Alberta today comes from coal-fired generators. This fact, together with the rapid projected growth rates for electrical heating as indicated in Table X, has led some in the coal industry to view the projection in a completely different light.

2. Nuclear Power. Boundless optimism today would be equally as unjustified, however, as was the ill-concealed pessimism of 1945. Although coal-fired thermal units will be important power sources in the year 2000, it is expected that fully one half of all

---

[22]Canada, Royal Commission on the Coal Industry of Canada. Submission on the Coal Resources and Coal Industry of Alberta, Edmonton, 1945, p. k-3.

electricity consumed in the United States at that time will be produced in nuclear stations.[23]

What role is nuclear power expected to play in the near future in Canada, and particularly in Alberta? In 1946 Dr. C. J. Mackenzie, president of the National Research Council, stated that costs of nuclear power would begin to approximate coal or hydro power by 1966.[24] It might appear that this prediction was unerring, given that Ontario Hydro's Douglas Point station located on the shore of Lake Huron will be completed in 1966. With a capacity of 200,000 kilowatts, it will be Canada's first full-scale nuclear generating station. Even more significant is the Pickering nuclear station now under construction twenty miles east of Toronto. This project is the largest nuclear plant at any stage of planning, construction, or operation anywhere in North America. Its initial capacity when it goes on stream in 1970 will be 1,080,000 kilowatts. By 1975 this will have been increased to 3,000,000 kilowatts, at which time Pickering may be the largest nuclear station in the world. Thus within a comparatively short time, a significant portion of Canada's major industrial region will be dependent upon nuclear power. However, both Pickering and Douglas Point will be operated under an agreement with Atomic Energy of Canada which will absorb all nuclear power generation costs above the average generating costs of Ontario Hydro's other stations. Competitive nuclear power is thus still many years away.

---

[23]Landsberg, op. cit., p. 198.

[24]Canada, Report of the Royal Commission on Coal, 1946, Ottawa, 1947, p. 416.

Competitive or not, this nuclear development is of considerable importance to Alberta's coal industry. For decades, coal operators here have attempted to capture some segments of the large Ontario market. This market now lies entirely in the field of thermal power generation. Despite operating and planned nuclear stations in southern Ontario, the supply of Alberta coal to thermal stations in that region remains a very worthwhile goal, given the construction of Lambton and Lakeview stations as referred to above (p. 117). However it is apparent that nuclear stations will account for much of the growth in Ontario's electrical power output in the next twenty years.

Nuclear power will be much slower in coming to Alberta itself than to Ontario. Market concentrations are not as large in Alberta. Such markets are essential to sustain the large scale nuclear stations which are necessary to achieve maximum efficiency. Even more important, Alberta has abundant reserves of other sources of power immediately at hand, whereas Ontario's reserves are negligible. Officials of Canadian Utilities Limited stated in 1958 that, "It is our belief that Alberta Utilities will not be interested in this new development [atomic power] for some time, in view of the abundance of coal and natural gas available for fuel at reasonable rates in our province."[25]

Nuclear power will thus remain in the background in Alberta in the immediate future. Whether in the background or foreground, however, its presence is significant. The knowledge that the cost gap between nuclear power and "conventional" thermal or hydro power is steadily decreasing, forces power producers in the province to keep their operations as efficient as possible. J. G. MacGregor, Chairman of the Alberta Power Commission, stated in 1964 that, "In perhaps twenty years in Alberta it may well be

---

[25] J. N. Ford and W. I. McFarland, "Battle River Steam Station", The Engineering Journal, vol. 41, no. 1, January 1958, p. 78.

that nuclear power will set the upper limit of what can be paid per million B.T.U.s for coal for power generation."[26]

II. New Markets for Coal.

It would be imprudent for the coal industry to rely inordinately on the power generation market for its long term success. In addition it now appears unlikely that coal will make a significant return either in the transportation industry or in residential space heating. It would appear that if coal is to hold an important position in Alberta's future economy, basic changes must occur in the industry.

Virtually throughout its entire history, the Alberta coal industry has depended upon production of a high-bulk, low-value commodity, primarily for sale within a regional market. These mass markets have nearly all collapsed in the post-war era, and it is possible that one of the two remaining significant markets, that of the supply of fuel to thermal power stations, could face considerable competition in the not too distant future from new sources of energy, particularly nuclear power. Thus it would seem that if coal is to survive as an important material in the technological age, the coal industry itself must undergo reorientation to bring it into line with the general precepts of modern technological industry. It must look to new markets where increasingly the demands are for secondarily processed goods of low bulk and high value. Such markets will generally involve much smaller tonnages than the mass markets of the past. The value per unit weight of product would be much greater however. "The manufacture of chemicals and

---

[26] J. G. MacGregor, "Coal for Electricity in Alberta", Proc., Sixteenth Dominion-Provincial Conference on Coal, Lake Louise, September 3-4, 1964, p. 4.

structural carbons from coal would of course not require very large tonnages of raw coal, but would nevertheless be of tremendous value to Alberta's coal industry."[27]

One advantage of the low bulk, high value commodity is its ability to withstand higher transport costs. Thus any processing of Alberta coal in this province aids it in crossing the barrier of distance to markets which has long been such an obstacle. The research on molecular sieves currently in progress at the Research Council of Alberta has prompted enquiries from the United States, Europe, Japan, and Australia. With the increasing importance of low-bulk, high-value commodities, national and international markets will play ever more significant roles in Alberta's coal industry.

A. Changing Attitudes Towards Coal.

If such a transformation is to take place in the industry, the cool operators themselves must fully support it. One of the problems which has beset the coal industry in the past has been the conservatism of management. Coal mining has a much longer history than many of the leading industries in Alberta's economy today, and too often the coal operators have adhered to mining methods and marketing policies which have proved themselves in the past, but which are impractical under today's economic conditions. With the collapse of the mass markets utilizing coal simply as a mineral fuel, too many resigned themselves to supplying the small residual markets rather than seeking out new markets. There was an apparent lack of appreciation of the

---

[27]Canada, Royal Commission on Energy, Submission by the Coal Operators' Association of Western Canada and the Western Canada Coal Utilization Council, Regina, April 1958, p. 22.

research work in coal utilization by the Research Council of Alberta (R.C.A.) and the Division of Fuels, Department of Mines and Technical Surveys. The brief presented by the Coal Operators' Association of Western Canada in 1960 to the Royal Commission on Coal suggested that ". . . emphasis should be placed on the low cost bulk usage of coal rather than on specialized uses which involve low tonnage and high capital costs per unit of throughput."[28] Many in the industry thus continued to think of coal only as a fuel. They regarded as somewhat esoteric research into the use of coal as a basic raw material, as a source of chemicals such as phenols, dyes and industrial solvents. An integrated coal industry involving recovery of valuable by-products as occurs in the oil industry was given little consideration.

However, a very marked change has taken place in the past five years concerning the attitude toward coal. Many industrial fuel consumers which converted to oil or natural gas in the 1950s are re-examining coal. Oil companies themselves are becoming increasingly interested in coal's future and are buying coal properties.

Most important has been the change in attitude among the coal operators themselves. Research efforts are strongly encouraged. Four major Alberta producers provided financial assistance for the R.C.A.'s work in the field of active carbons. They were the Canmore Mines, Coleman Collieries, Forestburg Collieries, and Lethbridge Collieries.

B. Coke.

The new attitude in the industry will mean a greater effort to find and develop markets which can be served almost exclusively

---

[28]Canada, Royal Commission on Coal, (1959), Submission by the Coal Operators' Association of Western Canada, Calgary, March 31, 1960, p. 15.

by coal alone, since under present conditions of extraction and transportation coal is at a distinct disadvantage when competing against oil and natural gas. The supply of exclusive or captive markets will not mark an entirely new development within the industry, since from the 1880s a substantial portion of Alberta coal has gone to one exclusive market, that of the manufacture of metallurgical coke (see Fig. 27).

Coke is the strong, porous, non-crumbling mass which is produced when the volatile matter is expelled from certain bituminous coals with extreme heating. When a non-coking coal is similarly heated, the product is only a powdery residue, unsuitable for metallurgical use.

Historically Alberta's leading producer of coking coal and of coke has been the Crowsnest district. International Coal and Coke Company began operations at Coleman in 1903. By 1908 this firm had established solid links with the metallurgical industry of British Columbia's Kootenay district, and fully half of the mine's daily output of 2,000 tons went to on-site coke ovens. The major coke market was the British Columbia Copper Company at Greenwood. By 1910 International's number of coke ovens had risen to 216. However shortly afterwards the bubble burst. The greatly over-developed metallurgical industry in British Columbia collapsed and by 1918 all coke ovens in the Alberta towns of the Crowsnest--Coleman, Lille, Passburg, and Frank--had ceased operations (see Fig. 27). Gradually market conditions improved and by the 1940s, International once more had over one

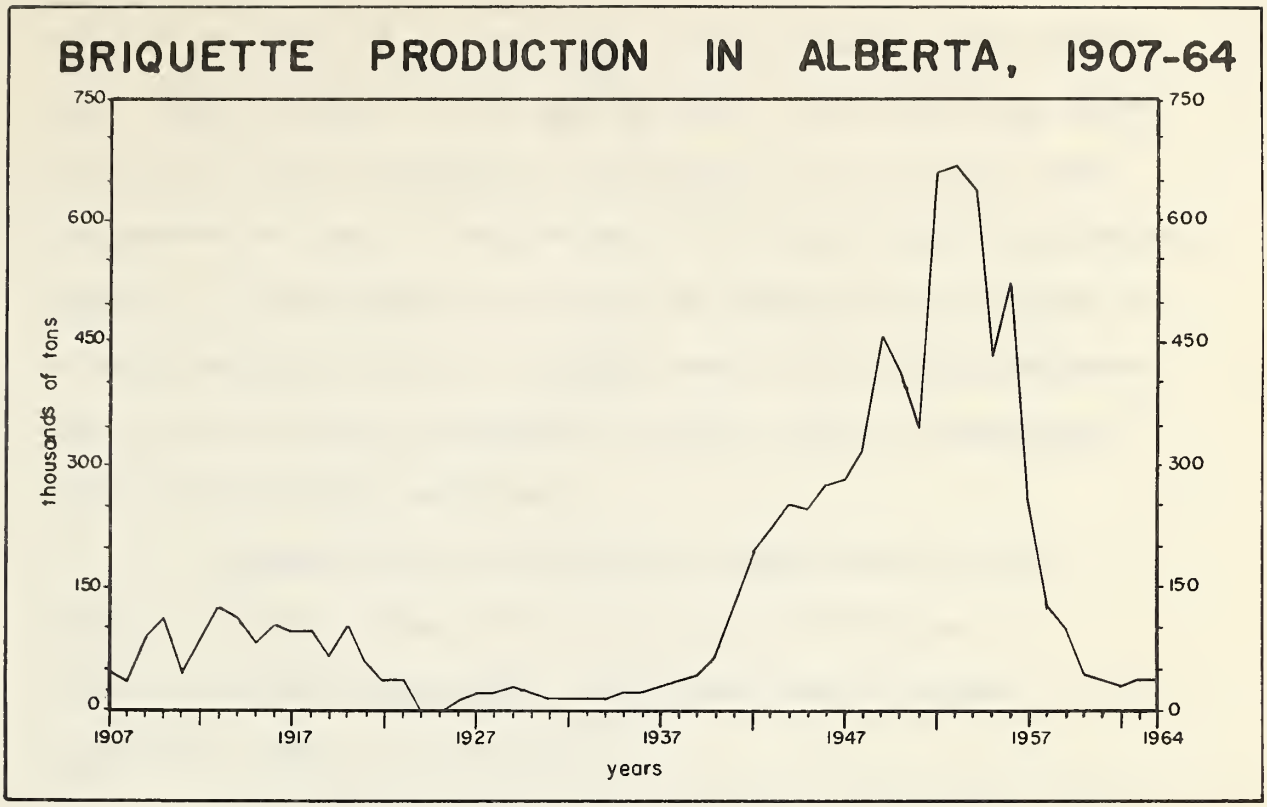
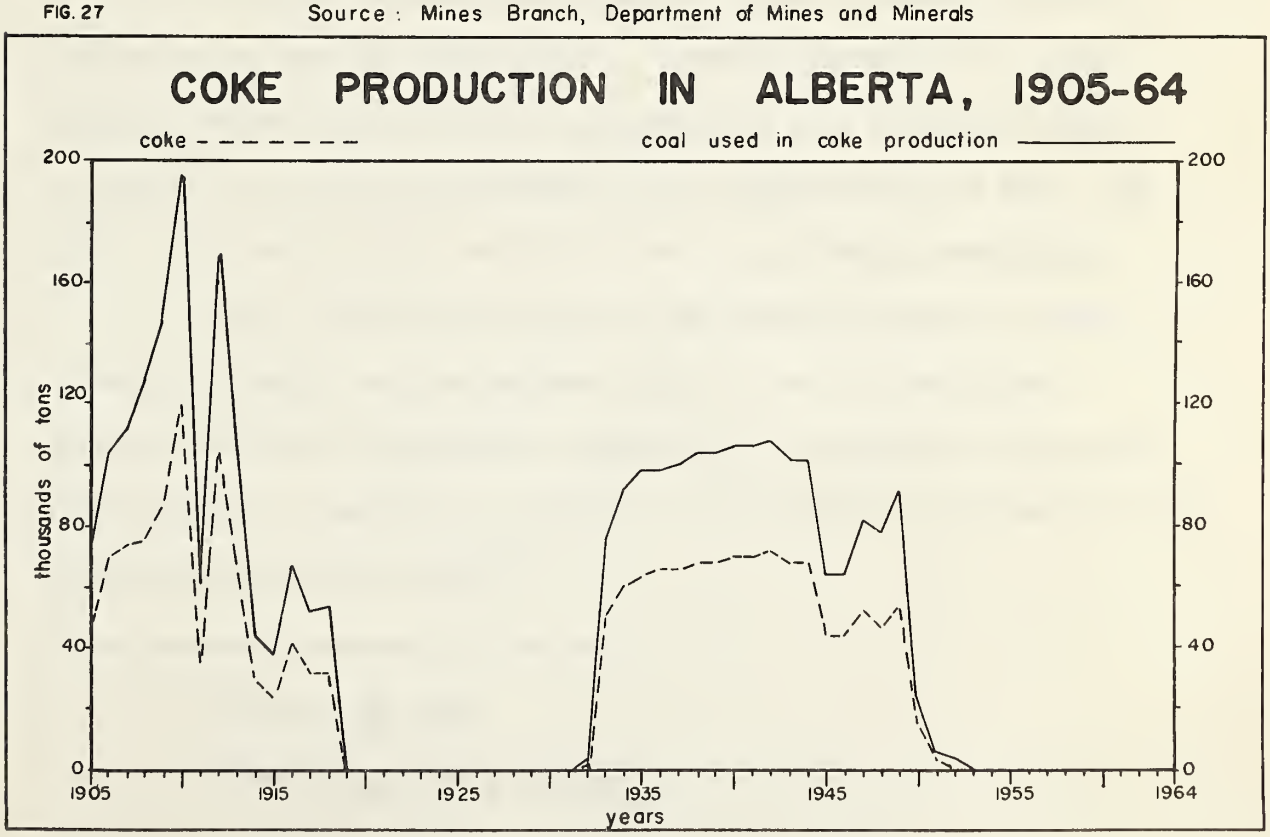


FIG. 27 Source : Mines Branch, Department of Mines and Minerals



hundred coke ovens in use, with annual coke production about 70,000 tons. Again, however, the success was short lived and by 1952 there were no coke ovens operating on the Alberta side of the Pass, with the shutdown of those at International and at West Canadian Collieries, Blairmore. International at the time had produced over 1,500,000 tons of coke beginning in 1904. Throughout most of the intervening period most of its coke had been marketed in Trail, center of Consolidated Mining and Smelting's operations.

Although there are currently no coke ovens in use in Alberta's Crowsnest communities, production of coking coal is still of overriding importance. Over 95 per cent of Coleman Collieries' output is of this type.[29]

The only Alberta firm presently using bituminous coal for production of coke is Canmore Mines. Company research into a high quality furnace coke resulted in construction of a full-scale plant in 1963 with an initial throughput of one hundred tons per day. The coke is particularly well suited to use in non-ferrous metallurgy.

Trail and Flin Flon are the two leading consumers of coke in western Canada, both using about 120,000 tons of coking coal annually in their metallurgical operations. The growth of these and other markets is expected to result in a near doubling of Canada's coke output between 1965 and 1980.[30]

---

[29]Upton, op. cit.

[30]Davis, op. cit., p. 92.

The western Canadian market for coke would be greatly increased were one or two large integrated steel mills to be established. There is now a steel mill at Kimberley and prospects for one on the prairies are good. The exploitation of oil and gas reserves in the past twenty years has aided the growth of industrial infra-structure. Iron ore is present in the Peace River district, and limestone in the Rockies. Of the prairie provinces, Alberta is the one most likely to be the location of an integrated steel industry since its population and markets have the highest growth rates and it has the greatest reserves of relevant resources.

However, the operations at Kimberley utilize char rather than coke. Blast furnaces in western Canada which would use large quantities of coke are still many years away. The demands of metallurgical centers in the western United States are also important for any future expansion of Alberta's coke output. This market was significant before World War I, and today such centers as East Helena and Butte, Montana, and Kellogg and Coeur d'Alene, Idaho, would be natural markets for Alberta coking coal or coke were it not for tariff barriers. Such artificial barriers cannot be maintained indefinitely however. The largest reserves of coking coal in North America are those of the Appalachian region but some experts believe that these reserves will have been exhausted at present mining depths by about 1980.[31] The second largest continental reserve occurs along the Continental Divide in southeastern British Columbia and southwestern Alberta. Reserves of coking coal in this region are approximately eighteen billion tons.[32] Hence within a

---

[31]J. S. Connolley, "Something Must Be Done About Coal", Western Miner, vol. 25, no. 10, October 1952, p. 80.

[32]T. G. Ewart, "Western Coking Coal Reserves", Transactions of the Canadian Institute of Mining and Metallurgy, vol. 55, 1952, p. 165.

relatively short period of time Alberta mines could be a major source of coke for steel centers in the western United States such as Geneva, Utah, and Fontana, California.

Changes in the technology of steel production could affect future Alberta coke production even more than the growth of markets and decline of other sources of supply. Generally speaking, improved blast furnace technology means a steady reduction in the amount of coke required per ton of finished steel. Use of higher grade, beneficiated iron ores, which is becoming more widespread, means comparatively less consumption of coke. Coke requirements are now as low as 1200 pounds per ton of hot metal produced.[33]

Currently nearly all steel mills in western Canada are electric furnaces which utilize only one half as much coke as the blast furnace. The latter requires much greater initial capital outlay and only a very large market concentration can justify its existence. Not all technological advances necessarily mean reduced coke consumption however. The relatively new oxygen steel process uses more coke than does the standard blast furnace. Moreover some of the ore beneficiation processes themselves involve utilization of coke fines.

Possibly the technological advances of the greatest import to Alberta's future coke production are those in the fields of the low-shaft blast furnace and production of coke-like reductants from low rank coals. The two areas of research are interconnected since the low-shaft

---

[33]J. C. Botham, "Blending of Canadian Coals for the Manufacture of Metallurgical Coke", Proc., Twelfth Dominion-Provincial Coal Research Conference, Ottawa, Oct. 13-15, 1960, p. 97.

blast furnace has the advantage of being able to utilize inferior materials. Notable advances in the use of coke derived from lignite have been made in East Germany where orthodox bituminous coking coal is scarce but lignite plentiful. The major disadvantage of the low-shaft blast furnace is that its fuel consumption is relatively high. This fact, plus the possibility of using low rank coals, led a group of Canadian researchers to say that, "The process would thus seem to be restricted in Canada to a cheap fuel area such as parts of the Prairie Provinces."[34]

If it does become economically practical to process Alberta's sub-bituminous coal for the production of coke for use in ferrous metallurgy, the coal industry would benefit considerably. Though Alberta has large reserves of bituminous coking coals, they are difficult to mine. Adaptability of strippable low-rank plains coal to coking purposes would be of great significance. It is noteworthy that a coke plant at Kemmerer, Wyoming utilizes coal of similar rank and composition to that produced by the two large stripping operations on the Battle River.[35] Admittedly the Wyoming operations are still at the pilot plant stage and economic feasibility remains in question.

At the present time, however, the major metallurgical markets for sub-bituminous Alberta coals lie in non-ferrous rather than ferrous metallurgy. Char, or soft coke, is a product of sub-bituminous coal.

---

[34]J. H. Walsh, J. C. Botham, and H. P. Hudson, "Present and Potential Uses for Coal in the Canadian Metallurgical Industry", Transactions of the Canadian Institute of Mining and Metallurgy, vol. 61, 1958, p. 60.

[35]Pers. comm., R. D. McBride, Halkirk, Aug. 20, 1965.

The operating plant of Lethbridge Collieries now consists solely of a plant producing such char from coal mined near Taber. About 40,000 tons of char are produced annually, from 60,000 to 80,000 tons of raw coal. This soft coke is shipped to Kimberley for use as an open-hearth reductant in the lead-zinc works.

C. The Carbochemical Industry.

The production of coke is significant in another way. For some years a number of visionaries have looked to the carbochemical industry as a panacea for Alberta's coal industry. The traditional carbochemical industry basically involves the recovery of coal tar and volatile matter, as well as coke, from the high temperature carbonization of coal in recovery-type coke ovens. The number of products which it is physically possible to derive from this carbonization process is extremely great and varied.

However, equally as important economically as the physical capacity to produce a given commodity, is the capacity to sell it. The lack of adequate markets is the major obstacle confronting a carbochemical industry in Alberta. To the extent that they exist at all, they can usually be supplied more inexpensively with comparable products derived from oil or natural gas bases. In most cases, however, adequate markets simply do not exist.

The type of market necessary to warrant a large scale carbochemical industry is one of the most complex which can be developed through human activity and also one of the most rare. It must be capable of absorbing a large volume and wide range of products at one geographical location. Coke, tar, and volatile matter all are utilized as raw materials for the production of finished goods after further

processing. Unless markets exist for the products of each of these sub-processes and unless an approximate balance can be maintained between them, the efficiency of the overall operation will soon be greatly reduced. Industries which are thus wholly or partially dependent upon marketability of various by-products are to some extent parasitic, unable to exist independently. Thus the amount of coal tar produced often depends very largely on the demand not for coal tar but for coke.

The type of market necessary is therefore one which is marked by a large concentration of population and even more important, a large concentration of heavy and light industries comprising an integrated industrial region. Such industrial regions certainly do not occur in Alberta at present and in fact are very few in number even on a world scale. Some examples would include the Upper Ohio River region of the United States, parts of the English Midlands, and West Germany's Ruhr region. Even in the United States, with an industrial output far exceeding that of any other country, ". . . non-energy uses of coal are insignificant relative to total coal use."[36]

These facts should be borne in mind when considering the chances that a large-scale carbochemical industry might rejuvenate the coal industry in Alberta where industrial regions of the type occurring in the northeastern United States are non-existent. Moreover the petrochemical industry still enjoys a considerable cost advantage in the production of most commodities which might also be manufactured by

---

[36]Schurr and Netschert, op. cit., p. 250.

carbochemical methods. There are several other interesting relationships between the petrochemical industry on the one hand and the coal industry and any carbochemical industries on the other. Some representatives of the coal industry note the limited reserves of oil and gas, and hold that coal will eventually be the source of hydrocarbons for Alberta's current petrochemical plants. Such a development seems unlikely. Coal's properties, both physical and chemical, are much more variable than are those of the petroleum bases, and adaptation of existing plant to a new source of raw material would probably be unfeasible. More important is the fact that coal contains, on a comparative basis, very little hydrogen.

However certain chemical products can now be produced more economically from coal than from petroleum bases. These include toluene and benzene. Moreover there appear to be good market prospects for the carbochemical industry in the fields of synthetic rubber, synthetic fibers, plastics, insecticides, and dyes, all of which involve the use of toluene and benzene.

Considerable progress has been made in Alberta in recent years in research into the production of specific chemical products from coal. Moreover, "certain chemical companies . . . [have] been buying up deposits where sub-bituminous and lignitic coals can be mined mechanically and at comparatively low cost."[37] Thus, although a large-scale integrated carbochemical industry for Alberta is still many years

---

[37]Davis, op. cit., p. 70.

away, a more detailed look at the industry would appear to be justified.

The end products of the carbochemical industry are numberless. They include perfumes and alcohols, vegetable oils and paints, drugs and explosives, fertilizers and acetylene, artificial graphite and ammonia. Some are of more relevance than others with respect to the Alberta coal industry, either because the regional market for them is considerable or because conditions make it practical to produce them here for sale to distant markets.

1. Carbonization. The great diversity in rank of Alberta coals is a decided advantage for any carbochemical industry. Different coals can be utilized according to their suitability for specific manufacturing processes. This is particularly applicable to carbonization, the heating of coal to break it down into a solid residue, tar, light oils, and gases. The lower rank coals, which can be strip-mined efficiently in Alberta, can be processed in this way, with carbonization occurring at relatively low temperatures. The residue, a char or semi-coke, can be briquetted for use as a fuel, or used metallurgically. The tar and light oils can be processed to yield such things as ethylene and styrene, the latter a component of synthetic rubber.

Successful commercial ventures based on low-temperature carbonization of lignite have been established in Texas and Saskatchewan. The Texas operations, such as those of Milan County, are much more economically viable, since market conditions make possible the more complete utilization of the non-solid by-products of carbonization.

Development of markets for tar from low or medium temperature carbonization is hampered by the fact that this tar is generally much less valuable as a chemical raw material than that produced in the carbonization of high rank coals.

2. Gasification. One of the basic processes in the chemical utilization of coal is gasification, either partial or complete. The combination of gases given off in the coking process or destructive distillation of coal is known as coal gas. It consists mainly of methane and hydrogen with some carbon monoxide. It can be used as a domestic fuel but this use does not occur in Alberta today due to the competition of natural gas. The latter consists largely of methane and has a heat value of about 1000 B.T.U. per cubic foot compared to a figure of approximately 600 for coal gas. Alberta's abundant natural gas reserves and lack of a well-developed integrated industrial market have also effectively prevented the use here of other combinations of gases derived from coal such as producer gas and water gas. Gasification of coal is now almost competitive in Ontario where fuel is scarce. However until some practical means is discovered of increasing the heat value of the various combinations of gases which can be manufactured from coal bases, gasification will be unimportant in Alberta.

3. Hydrogenation. Hydrogenation is another large field within the carbochemical industry. It involves the introduction of hydrogen to a low rank coal and combination of the hydrogen with some of the carbon contained in the coal. If the process is carried out under high temperatures and pressures, the coal is liquified and can

be treated to produce liquid fuels including gasoline and diesel fuel. The possibility of the widespread use of coal to produce diesel fuel has prompted speculation that coal may in this way regain much of the railroad market.[38] Hydrogenation can also be applied to the manufacture of gaseous fuels and may eventually result in a competitor for natural gas.

Many valuable non-fuel products can be obtained from hydrogenation. It is generally felt that non-fuel applications have more chance for economic success in Alberta than would a hydrogenation complex oriented more exclusively to the manufacture of liquid and gaseous fuels. The fuel market here, though large and continually expanding, is more than adequately served by petroleum fuels.

A commercially viable hydrogenation industry exists today only in South Africa. Important research is also being carried out in the United Kingdom and in the country where much of the earliest work in the field was done, West Germany. All these countries have abundant coal reserves, but lack adequate reserves of petroleum and natural gas. It is noteworthy that prior to the Alberta oil discoveries of 1947, several large firms had plans fairly well advanced for the establishment of synthetic liquid fuel plants based on Alberta coal.[39] Even more significant is the fact that since 1963 several major oil companies with operations in western Canada have obtained leases on coal properties and increased their research outlays in the conversion

---

[38] W. E. Uren, "Canadian Coal in the Years Ahead", Western Miner, vol. 27, no. 11, November, 1954, p. 65.

[39] J. E. Oberholtzer, "The Role of Non Metallic Minerals and Coal in the Industrialization of Western Canada", Transactions of the Canadian Institute of Mining and Metallurgy, vol. 56, 1953, p. 230.

of coal to liquid fuels.[40] Indeed some sources hold that coal will be an important source of liquid fuels on this continent as early as 1973.[41]

4. Active Carbons. In both gasification and hydrogenation, the end products face very strong competition from petroleum base products. It follows that a carbochemical industry has its best chance for success if it focuses instead on products where it enjoys a definite cost advantage. This occurs, for example, when carbon alone is the major component of the end product. Hence one field on which the Research Council of Alberta has placed much emphasis is that concerned with active or activated carbons. Although active carbons can be produced from any organic material, coal is among the most efficient source materials. Moreover the wide range of rank in Alberta coals is a distinct advantage. Variation of the raw material facilitates production of a variety of active carbons suited specifically to a given use.

Active carbons are amorphous and highly absorbent with respect to both liquids and gases. Absorbency varies directly with surface area. Thus the process of activating the carbon source involves first an enlargement of the pore system, and therefore of the absorptive capacity, and secondly surface cleaning.

The characteristically high absorbency determines the uses to which active carbons are put. They find ready markets in the

---

[40] N. Berkowitz, "Coal Research in Canada, 1963", The Canadian Mining and Metallurgical Bulletin, September, 1964, p. 956.

[41] Calgary Power Limited, Alberta--Province of Opportunity, Calgary, 1958, p. 158.

purification of water and of food, in the manufacture of drugs and cosmetics, and in the recovery of industrial solvents. In all these instances, active carbons are used to remove taste, odor, or color from solutions.

Active carbons used in gaseous phase operations do not have as large a market, though it is growing. They are used in air-conditioning systems and anti-pollution devices. They are also important catalysts in the chemical industry, particularly in the manufacture of plastics.

Until very recently Canada has imported all its active carbons from the United States. However a joint program sponsored by the R.C.A. and four major Alberta coal firms (plus another in British Columbia) is about to bear fruit. Active carbons are now being produced by Western Coal Carbons and Chemicals Limited of Calgary. The four Alberta firms are Coleman Collieries, Canmore Mines, Forestburg Collieries, and Lethbridge Collieries. This venture is a significant step in establishing an important secondary coal industry in Alberta, one which substantially manufactures its products, and therefore one for which the market prices are higher.

Initially the Calgary plant will be aiming at the water treatment market and the chemical industries, and later at the natural gas processing industry. "Ultimate production could reach several thousand tons annually with the products selling at an average of 20 cents/lb."[42] About five tons of coal, including that used in heating and steam raising, would be required for each ton of active carbon produced.

---

[42]Berkowitz, "Coal as a Non-Fuel Source Material: The Present Status", op. cit., p. 27.

5. Molecular Sieves. Closely related to the work on active carbons by the R.C.A. is work in the field of molecular sieves. Just as the absorbency of active carbons depends to a large extent on its pore system, so the effectiveness of the molecular sieve is based upon pore sizes which exclude molecules exceeding a given size. For example a molecular sieve may permit the passage of nitrogen but prevent the passage of methane. It thus finds a ready market in natural gas processing plants and in water treatment plants. Like active carbons, molecular sieves are high value, low bulk commodities which would be marketed internationally.

6. Coal-based Fertilizers. Potentially one of the most significant developments in the carbochemical industry concerns the production of organic fertilizers from Alberta's sub-bituminous coals. The latter are oxidized to produce humic acids which are used in manufacturing sustained-nitrogen-release fertilizers. The natural nitrogen content of humic acids is 1-3 per cent. The materials produced by the R.C.A. have a nitrogen content of 20-25 per cent, with the nitrogen being released for up to two years after the application of the fertilizer.[43]

From a market standpoint, it is significant that unlike many of the recently developed carbochemical uses for coal, the production of coal-based fertilizers would involve relatively large tonnages, quite possibly 250,000 tons per year.[44] Such fertilizers would be especially

---

[43]Pers. Comm., Berkowitz, Edmonton, May 17, 1965.

[44]Loc. cit.

applicable for use on the grey wooded soils of Alberta's pioneer fringe. British Columbia's forest harvests could also be greatly enhanced through their use. With respect to international markets, these fertilizers have been proven effective in Japan and India.

D. Structural Carbons.

For many years the scientists and economists attempting to encourage the use of coal in a wide variety of ways, carried on a campaign urging the public at large, as well as those in the coal industry, to think of coal not merely as a fuel, but as a source of chemical raw materials. Today there is yet another step. It is no longer sufficient to think of coal as a fuel and as a source of chemicals. In addition it must also be regarded as a valuable structural material. Research in carbon ceramics emphasizes coal's structural properties. Fibreglass and asphalt binder are two common ingredients of carbon ceramic material other than the coal itself. The material is then used in the production of such things as corrosion-resistant tubes and linings for blast furnaces and acid containers. As in the case of active carbons and molecular sieves, the use of coal in structural carbons would involve considerable secondary processing resulting in an end product which would command a relatively high price. This fact, combined with the ready availability of suitable coals, provides a basis for such an industry in Alberta.

E. A Capital Intensive Coal Industry.

Again such a secondary industry would involve production of a high-value but low-bulk product. The scale of production of some of

these secondary processes is indicated by the fact that outputs of active carbons are measured not in tons but in pounds. The importance of such production must continue to rise if the coal industry is to be economically viable. This has necessitated considerable change of thinking within the industry. It is worth noting that even in the research field this change in attitude has come about only fairly recently. As late as 1957 it was stated that the Fuels Division of the Mines Branch of the Department of Mines and Technical Surveys was concentrating its research efforts ". . . in the field of applied coal research, particularly in those areas which are thought to give rise to large bulk uses of coal."[45] However in 1965 Dr. Berkowitz of the R.C.A. wrote as follows:

> There is a general tendency to view novel coal utilization schemes primarily as replacements for lost fuel markets, and to judge their value solely on the basis of whether or not they can, individually, assist the coal industry to regain 'economic health', i.e., whether or not they can restore lost tonnages. If this yardstick is retained, none of the several non-fuel uses now thought practicable would be significant.[46]

The equating of a successful coal industry with large tonnages must be abandoned. Success of an industry must be measured not in tons of output but in dollars of profit. Often the issue has been

---

[45] Proc., Ninth Dominion-Provincial Coal Research Conference, Edmonton, August 30-September 1, 1957, p. 30.

[46] Berkowitz, "Coal as a Non-Fuel Source Material: The Present Status", op. cit., p. 27.

clouded in the past by the labor factor, and the equating of a successful coal industry not only with tons of output, but with numbers of employees. Too often, however, the hundreds of employees had minimal job security, with seasonal layoffs virtually the rule in all plains mines. It would appear preferable to have a sound, technologically advanced secondary industry providing good job security for twenty persons than to have an operation based on the sale of large tonnages of raw material to declining markets while providing tenuous employment for one hundred persons.

CHAPTER V

EXTENDING THE MARKET FOR ALBERTA COAL

I. Coal Preparation.

If the coal industry is to survive in any form, and particularly if it is to become more oriented to new technological markets, then more attention must be given to coal preparation. Preparation may be simply defined as ". . . action taken to improve the quality of coal from its natural state."[1] It thus involves some degree of treatment or processing of the "mine run" (i.e., coal as it comes from the mine), in order to improve its marketability. Preparation includes screening to ensure a relatively uniform size product. Coal may be treated with spray to counteract coal dust. Cleaning is the most important form of preparation. Much of the undesirable ash, rock, and inorganic sulfur is thereby removed. Cleaning may be accomplished in several ways, including flotation, suspension, and centrifugal processes. This type of preparation has long been an important part of Alberta's coal industry. The very high ash content of Crowsnest coals, which led to the abandonment of so many mines there at about the time of World War I, forced the remaining operations to take compensating action. First to do so were the Greenhill Mine at Blairmore and the McGillivray Mine at Coleman in the mid-1920s.

A. Briquettes.

Briquetting may be considered to be a form of preparation. It has a comparatively long history in Alberta, with the first

---

[1] American Coal Sales Association, op. cit., p. B-26.

briquetting plant in western Canada having been built at Bankhead in 1907. The plant processed semi-anthracite for use in C.P.R. locomotives, and remained in operation until the Bankhead mine itself closed in 1923 (see Plate III).

1. The Briquetting Process. Briquetting basically involves the subjection of coal to high pressures, with or without the addition of an adhesive material known as a binder. The result is a more compact and more easily transportable material, and one with considerably higher market value than mine run coal. Moreover the application of pressure simulates the pressures which coal would be subjected to in its natural state due to overlying strata or orogenic forces. Thus briquetting, in effect, increases the rank of the coal, with the end product having a lower moisture content and a correspondingly higher B.T.U. rating than the raw coal.

At various times in Alberta's history, briquetting has been hailed as one of the chief means of saving the coal industry, of enabling it to compete more easily with competitive fuels. It is somewhat ironic, therefore, and yet not atypical of Alberta's coal industry, that the briquetting plants have almost always used an asphalt binder and have therefore been partially dependent themselves upon the oil refineries to supply them with one of their key materials. The asphalt binder itself has a high calorific value (about 17,900 B.T.U. per pound) and therefore adds to the final heat value of the briquette.

Desirable qualities in a finished briquette include convenient handling size, strength, resistance to abrasion and weathering, a low ash content, high calorific value, and the capacity to burn freely.

The properties will depend upon the rank of coal used, the type of binder, and the process employed.

Briquetting of low rank coals is possible but expensive. Often it is desirable that such coals be carbonized first due to the high moisture content, with the resultant char then being briquetted.

2. Briquetting Plants in Alberta. High rank coals have always been much more important than the lower ranks in Alberta's output of briquettes. The high rank mountain coals are generally highly friable due to the orogenic history of these areas. Accordingly fines comprised 50-75 per cent of the mine run of some of the mountain mines. The market for fines was severely restricted. The railroads, major market of the mountain mines for decades, could not use such coal in their locomotives. Briquetting was the answer. Production of a marketable fuel from fines that would otherwise have been wasted was therefore the basis of the large briquetting plants in the mountain districts. Bankhead was the site of the first such plant, followed by Canmore in 1925. A second plant was built at Canmore in 1947.

The largest briquetting plant ever to operate in Alberta was that of Brazeau Collieries at Nordegg, beginning in 1936. By 1949 four briquetting units were in use at this site, with a combined daily output of 1,500 tons. However, in the following year all four were destroyed in a fire. Construction began immediately on a $2,000,000 modern plant including four briquetting units and cleaning equipment.

By 1952, daily capacity had surpassed 1949 levels, and by 1953, the entire coal output of Brazeau Collieries was being briquetted. Yet in January, 1955, the whole mining complex ceased operations. The new modern plant had been in use only slightly more than three years. Competitive fuels and excessive distance from eastern markets proved insurmountable obstacles.

The first binderless briquetting plant in North America began operations at Blairmore in 1941. In 1947, however, the firm, West Canadian Collieries, shifted to the use of a binder.

The first and only briquetting plant to be built on the Coal Branch was that of Luscar Coals in 1949. Both this operation and the one at Blairmore were much smaller than that at Nordegg, but like the latter they ceased production in the mid-1950s, marking the end of the period of major importance of briquetting in Alberta. Production had risen from about 25,000 tons in 1937 to about 285,000 tons in 1941 and about 455,000 tons in 1949, with Brazeau Collieries accounting for two-thirds of the latter total.[2] Today, however, the only significant briquetting operation in Alberta is that at Canmore, and even it has a much smaller output than it had in the 1940s (see Fig. 27).

There were two main reasons for the great increase of briquette production during the 1940s. One was wartime demand. The other was the increasing amount of fines in the mine run of Brazeau Collieries, the major center of briquetting. The increase in fines was a result of poor geological conditions and greater use of mechanized mining techniques.

---

[2] W. A. Lang, The Briquetting of Alberta Coals, Edmonton, 1950, p. 6

3. Markets for Briquettes. The two major markets for briquettes during this period of their greatest importance were the same as those for coal itself--the household fuel market and the railroads. Over the period 1943-49, about 60 per cent of Alberta's briquette output was sold as domestic fuel. It is interesting to note the place of Alberta itself compared to the other provinces in this market. Of the total tonnage of briquettes sold as household fuel during this time, Alberta accounted for less than 10 per cent while Manitoba accounted for more than 30 per cent. Even more surprising is the figure of 20 per cent for Ontario. These figures reflect the fact that briquettes, as a product of some degree of secondary manufacturing, are better able to stand transport costs than is coal itself.

The railroad market became increasingly important for the briquetting industry in the early 1950s. Thus precisely at the time when dieselization of the railroads was progressing at a rapid rate, the producers of briquettes found themselves in the unfortunate position of becoming increasingly dependent on this market. Their other major market was also being eroded as natural gas and petroleum were becoming more readily available to the consumer of household fuel. The result is that briquetting is much less important now than it was in 1950 (see Fig. 27).

B. Mechanized Mining and the Need for Coal Preparation.

Other forms of coal preparation are becoming ever more important, however. One reason for this is that mechanized mining,

TABLE XI[3]

ALBERTA'S BRIQUETTE OUTPUT AND THE IMPORTANCE OF THE RAILROAD MARKET FOR SELECTED YEARS, 1943-1955.

Year	Briquette Output (in thousands of tons)	Sold to Railroads	
		thousands of tons	Percentage of total
1943	222	61	27
1945	250	126	50
1947	283	84	29
1949	461	254	55
1951	344	208	60
1953	665	575	86
1955	438	350	80

[3]W. A. Lang, The Briquetting of Alberta Coals, Research Council of Alberta, Contribution 22, Edmonton, 19 , p. 6.

though ultimately more efficient, inevitably results in a product with a greater percentage of impurities than does mining which depends more on individual miners and their ability to select the higher grade parts of the seams. Some mechanized firms still find it practical to depend on such selective mining, and are able to dispense with cleaning facilities. This applies to Amalgamated Coals of East Coulee, which works only 5-8 feet of a 10-12 foot seam in its underground operations, and to the strip operations of Battle River Coal Company whose preparation facilities are restricted to sizing.

C. Quality Requirements of Current Markets.

The second reason why coal preparation is becoming more significant concerns the market factor. In modern industry the stress is on quality control, which means that to sell in technological markets, coal operators must meet increasingly more stringent requirements with respect to size, quality, and uniformity of their product. This is not an entirely new development. Inability to maintain a supply of coal of uniform size, ash content, volatility, and calorific value considerably hindered the efforts of Alberta operators in the 1930s when a concerted drive was launched to dislodge United States coal from the Ontario market. Irrational and nefarious business practices were responsible for much of the difficulty.

Today, however, the emphasis on quality is much greater. In the past, investment in preparation facilities in Alberta has generally been relatively small, limited usually to sizing and some ash removal. Now, however, more costly preparation operations are essential if Alberta's coal industry is to increase its share of the technological

markets. Japan's demand for coal for its metallurgical industries is a leading example of such a market. If Alberta producers are unable to maintain a supply of satisfactory quality, such technological markets will be lost, either to other coal producers or to suppliers of competitive fuels. An example of the latter situation was the conversion of Canada Cement's Exshaw plant from coal to natural gas.

The thermal power generation market is a partial exception to the generalization that industrial technological markets demand high quality coal. On the contrary, thermal power stations can operate quite satisfactorily using coal which is high in ash and moisture content, and which is highly friable, all characteristics which generally greatly restrict coal's marketability. Mining operations oriented to this market, therefore, require few preparation facilities. For example, of a total work force of sixty at Alberta Coal's Whitewood Mine, only two are employed in coal preparation. Hence a very high percentage of the labor force is employed in actual coal production, a fact contributing to the high productivity figure of seventy-five tons per man-shift.

However even though quality per se is relatively unimportant in coal used as a source of thermal power, uniformity is important, particularly with respect to volatility characteristics. Hence a low quality coal is satisfactory provided that it is of uniform low quality so that facilities can be adjusted accordingly. Preparation as such is therefore unnecessary. Past trends are thus being continued

for though a significant proportion of the province's bituminous output has for decades undergone some degree of preparation, there has been very little preparation of sub-bituminous coal.

The coal now used in major thermal stations is first crushed or pulverized. The result is an ironic problem faced by producers like Subway Coal of Rosedale, near Drumheller. The mine run is largely lump coal, yet before Subway can sell it for use in the Drumheller power plant, it must first crush it. However the slack so produced actually has a market value lower than that of the original lump coal. This reflects an outdated price system established when the household fuel market was dominant, and when "Drumheller lump" was most in demand.

II. Changing Distribution Patterns for Alberta Coal.

The increasing emphasis on technological and industrial markets will naturally lead to some changes in the distribution patterns of the products of Alberta's coal industry. The changes will not signal an entirely new development, however, since Alberta mines have long marketed their product over a wide area. The bituminous mines in particular often marketed over 80 per cent of their output outside the province (see Figs. 13, 24 & 25). The proportion of Alberta's sub-bituminous output leaving the province has always been much smaller and will continue to be so, due to the orientation of large strip operations to thermal generating stations on or adjacent to the coalfields.

A. Western Canada Markets.

The British Columbia market as a whole has never been as important to Alberta coal operators as has that of Saskatchewan. The major domestic fuel market, the Lower Mainland, was easily served by imported petroleum, and in the last decade by oil and gas pipelines from Alberta. However on a smaller and more localized scale, the metallurgical industries of the Kootenays have been of considerable importance to Alberta's Crowsnest bituminous mines for over half a century. Today Consolidated Mining and Smelting's Trail operations consume 12 per cent of the total output of Coleman Collieries.[4]

Before 1918 the Manitoba coal market was served almost exclusively by United States anthracite producers. In the 1920s much of this market was captured by Alberta mines. This situation persisted until about 1950. A number of Alberta mines depended to a surprising degree on this market. For example in the years immediately following World War II, Bighorn and Saunders Creek Collieries near Nordegg were only selling about ten per cent of their output in Alberta and one per cent in British Columbia. Their major markets were in Saskatchewan, Manitoba, and the Lakehead. However these were largely household fuel markets and with the availability of petroleum and natural gas via pipelines, Alberta's coal sales in this area have declined greatly in the past fifteen years. Moreover such coal markets as have persisted are often supplied from the lignite fields of southeastern Saskatchewan which have been extensively

---

[4]Upton, op. cit.

developed in the post-war period. One Manitoba market which is still important to Alberta's coal industry is the metallurgical center of Flin Flon which accounts for about 5 per cent of the output of Coleman Collieries.

B. The Ontario Market.

Throughout much of the history of Alberta's coal industry, producers in this province have regarded the large market of central Canada as a panacea. If the Ontario market could be wrested from the Americans, prosperity for the coal industry of Alberta would presumably be assured. Yet attempts by Albertans to capture that market have met with very little success. For most of the period of the 1930s, the consumption of Alberta coal in central Canada did not exceed 65,000 tons (see Fig. 13). Unfair American competitive tactics, including dumping, increased the difficulties in obtaining a significant share of this market. However in 1941-42, Alberta and the Crowsnest area of British Columbia shipped 1,263,000 tons of coal to Ontario and Quebec, indicating the scale of movement possible when United States demands for its own coal are so great that it cannot maintain its exports. Today with market conditions again normal, central Canada has assumed its earlier position of insignificance for Alberta producers. Amalgamated Coals of East Coulee is one of the few Alberta mines shipping to Ontario and Quebec and even in this case, the two eastern provinces account for only two per cent of total output.[5] Moreover it is only with the aid of federal rail subventions that this small scale movement is possible.

---

[5]Hnatyshyn, op. cit.

C. The Export Market.

1. The United States. Before 1960, exports rarely accounted for more than two per cent of Alberta's coal sales (see Fig. 13). For most of that period the province's exports consisted solely of shipments to the United States. The latter market, like that of Ontario, has sometimes been regarded as the key to the prosperity of Alberta's coal industry. Yet again like that of Ontario, the United States market has never in fact been of very great significance to Alberta operators. It is true, however, that the burgeoning metallurgical industry in the Pacific Northwest of the United States was one source of impetus for the growth of the Crowsnest mining district early in the century. For a short time American railroads of the Northwest depended on Crowsnest mines for a significant proportion of their fuel. Great Northern alone took 750,000 tons annually.[6] This market was choked off early, however, by discriminatory freight rates and duties. Yet even without artificial trade barriers it is doubtful whether significant quantities of Alberta coal could be marketed in the Pacific Northwest. The railroad and domestic fuel markets have disappeared. Thermal power is insignificant in this region, and will become relatively even less important as full scale development of the Columbia River continues.

Belief in the existence of a large market for Alberta coal in the northern plains region of the United States has also been

---

[6]Canada, Royal Commission on Coal (1959), Submission of the Western Canada Fuel Association, Calgary, April 1960, App. 9.

widespread in the past. Highly placed Canadian politicians have at various times called for a negotiation of new tariffs with the United States to facilitate movement of Alberta coal into its "natural market area" in Montana and North Dakota.[7] However this natural market area is largely illusory. The region is neither heavily industrialized nor densely populated. Hence the market itself is relatively small. Moreover there are important coal producers in Wyoming, Montana, and North Dakota, which can efficiently serve such markets as do exist. The region also has considerable reserves of competitive fuels, particularly natural gas, as well as hydro power developments on the Missouri River, factors which limit considerably the sales of regional American coal producers themselves. Opportunities for increased exports of Alberta coal to this region are thus very unlikely.

Alberta sales to the United States have therefore rarely been of major significance. They did exceed 150,000 tons in 1918 due to wartime demand, but dropped steadily through the 1920s and by 1934 stood at only 14,000 tons.[8] World War II, however, brought another rapid rise, with over 400,000 tons of Alberta coal moving to the United States in 1943. With a return to normal economic conditions, the figure was less than one tenth of that amount by the mid-1950s. By 1963, exports to the United States fell to less than 6,000 tons (see Fig. 13).

---

[7]N. E. Tanner, "Coal Must Play Its Part", Western Miner, vol. 23, no. 12, December 1951, pp. 52-53.

[8]Alberta, Report of the Royal Commission Respecting the Coal Industry of the Province of Alberta, 1935, Edmonton, 1936, pp. 27-31.

Despite the trend in the post-war period, there is a possibility that Alberta sales in the United States may increase considerably by 1980 as American reserves of coking coal become seriously depleted.[9]

2. Japan. Much more important export markets, however, are to be found in Japan. The great economic recovery since 1945 has led to growing demands for coal. The market is a specialized one, because Japan is itself a large coal producer. It imports coals which will blend with domestic grades to produce a good coke or to yield a good coal for Japan's large carbochemical industries.

Alberta exported small quantities of coal to Japan in the early 1950s (a total of 46,000 tons in 1951 and 1952). By the mid-1950s the Japanese economic boom was well under way. Imports of coking and semi-coking coal exceeded 3,600,000 tons in 1957.[10] Accordingly it was decided to make a determined effort to enable Canadian coal producers to gain a significant share of this growing market. In the following year the Canadian Coal Mission, sponsored by the Dominion Coal Board and several leading bituminous operators, visited Japan. Members of the group personally toured steel plants and other industrial establishments and discussed market possibilities with Japanese industrialists. Later several leading Alberta firms including Coleman Collieries and West Canadian Collieries each provided

---

[9]Davis, op. cit., p. 76.

[10]T. G. Ewart, Japan, Export Market for Western Canadian Bituminous, address to the Calgary Branch, Canadian Institute of Mining and Metallurgy, January 28, 1964, p. 3.

the Fuels Division of the D.M.T.S. with 1,000 tons of coal for tests to determine the suitability of their coal for the Japanese markets. Blends of Japanese high volatile bituminous coals with medium and low volatile bituminous from Alberta and southeastern British Columbia yielded good quality coke. Test shipments to Japan followed in 1958, and after they proved satisfactory, exports began in earnest.

There is every reason to believe that the upward trend indicated in Figure 13 will continue and that it may reach 2,000,000 tons by 1970.[11] Canada is not Japan's major source of coking coal, with much larger tonnages being imported from the United States and Australia. Even if Canada were to do no more than maintain her present percentage share of the market, the tonnages exported will continue to rise, since according to the Japanese Ministry of Trade and Industry, Japan's imports of coking coal will more than double during the 1960s.[12] However in recent years Canada's share of the market has been rising. If productivity rates in our mountain mines continue to rise and methods of ocean transport of bulk materials continue to improve, Canada's share in this large market may increase still more.

---

[11] W. C. Whittaker, "Coal", Western Miner, vol. 38, no. 3, March 1965, p. 39.

[12] Ewart, op. cit., p. 5.

The Japanese market is of singular importance to Alberta's coal industry. Only two major bituminous mines are still operating in the province. It is perhaps significant that both are located on C.P.R. through routes linking them to tidewater at Port Moody, British Columbia. Both are heavily dependent upon the Japanese market. Coleman Collieries' output in 1964 was 555,000 tons of which nearly 80 per cent went to Japan, making the company almost as dependent upon one market as it was when the railroads absorbed most of its output. Of Canmore Mines' 1964 output of 240,000 tons, about 60 per cent went to Japan.

Not only are Alberta's only two major existing bituminous mines dependent upon the Japanese market. One of the chief reasons for the Alberta Resources Railway currently under construction northwest of Hinton is the provision of access to the Smoky River coalfield (see Fig. 10). When John MacVicar of the G.S.C. undertook preliminary investigation of this coalfield in 1923, he listed as markets the railroads, the household fuel market as far east as Winnipeg, and B.C.'s metallurgical industry.[13] The first two have since collapsed. Development of these deposits will depend instead, just as do Coleman and Canmore, on the Japanese market.

III. Coal Pipelines.

One factor which aided the growth of Alberta exports to Japan was the construction of efficient bulk-loading facilities at

---

[13]John MacVicar, "Preliminary Investigations of Coal Deposits on Smoky, Hay, and Berland Rivers, Alberta", Summ. Report, G.S.C., 1923, Part B, p. 62.

Port Moody, B.C., in 1960 (see Fig. 12). Increasing size and efficiency of ocean going freighters in recent years have also been significant. However one costly link still exists in the transport chain--the movement from Alberta to tidewater by rail. Only the payment of the federal rail subsidy to offset the high freight rates enables Alberta producers to compete in the Japanese market.

A. Methods of Pipelining Coal.

A development which offers promise of circumventing this costly rail movement, thus ensuring for Alberta producers a significant share of the Japanese market, and perhaps too of the Ontario market, is the solids pipeline. The first successes in this field involved movement of a coal-in-water slurry. Such a pipeline was used for a brief period in the mid-1950s to supply coal to a thermal power station in Cleveland, Ohio, from a coalfield near Cadiz about 110 miles south.

The costs of moving the water are substantial, however, and it was recognized by some that much greater overall economies could be achieved if the water were to be replaced as the vehicle of transmission by a more valuable liquid such as oil. These economies can be realized, however, only if both coal and oil occur in the same region and if markets for both are present in the terminal region. Both conditions are met in the Alberta-Ontario context. Moreover coal in an oil slurry is less susceptible to settling and to line blockage than is coal in a water slurry. Coal-in-oil slurries have the additional advantage that they can be used directly as a fuel without separation. Thus only a short time ago the most inexpensive method of transporting energy on a B.T.U. basis over distances greater than 750 miles was judged to be the coal-in-oil pipeline using coal with a high calorific

value such as is mined at Canmore and Coleman.[14] This is highly significant for Alberta since large reserves of coal and oil are often found quite close together.

The coal-in-oil slurry has already been superseded, however. Recent work by the R.C.A. has led to conclusions that the best method of pipelining solids is through the use of paste slugs, somewhat akin to a string of sausages, being moved in a hydrocarbon carrier. The paste slug method has many advantages. Power consumption for transmission is less than that for the slurry method. Retrieval at the final terminal involves fewer difficulties than those of separation of coal from oil. Moreover the paste slug method is very versatile. Other solids could be transported in a similar manner. Specifically, potash and sulfur as well as coal could be shipped from Alberta and Saskatchewan via the same pipeline to industrial regions to the east. The diversification would lend a greater degree of economic stability to the overall operation than would total dependency on one raw material which might be subject to severe price fluctuation. For these reasons the paste slug method is now definitely preferred over the slurry method.[15]

B. Comparative Costs of Transporting Coal by Rail and by Pipeline.

Since neither the coal-in-oil slurry method nor the paste slug method has actually been given a large scale trial under commercial

---

[14]G. A. Vissac and R. P. Charbonnier, "Comparison of Canadian Energy Prospects--Potential of Coal-in-Oil Fuels", The Engineering Journal, vol. 47, no. 4, April, 1964, p. 26.

[15]Pers. comm., N. Berkowitz, Edmonton, May 17, 1965.

conditions for a considerable length of time, it is difficult to compare transport costs accurately with those involved in rail movement of coal. However some investigators have concluded that the delivered price of Alberta coal after pipeline movement of, for example, 2,000 miles, would be less than half that of coal moved under existing freight rates. This conclusion was arrived at by two different studies, one concerned with stripped sub-bituminous coal, the other with bituminous coal mined underground.[15]

The coal operators have long contended that the freight rates levied for the movement of coal are inordinately high. Some are of the opinion that their charges would be proven correct if long distance solids pipelines were installed in Canada since the railroads would reply by reducing their own rates in order to retain the coal trade. Such a development did in fact occur in the United States after construction of the 110 mile coal pipeline in Ohio. The action of the railroads not only led the Ohio line to cease operations but also resulted in the indefinite postponement of a much larger project, the construction of a coal pipeline from West Virginia to bulk-loading facilities on the Atlantic coast at Hampton Roads.

It is unlikely, however, that a similar chain of events would occur were a large scale solids pipeline to be built in Canada.

---

[15] N. Berkowitz and E. J. Jensen, "On Possibilities for Pipelining Coal in Canada", Transactions of the Canadian Institute of Mining and Metallurgy, vol. 66, 1963, p. 261.

Vissac and Charbonnier, op. cit., pp. 23-24.

The Ohio pipeline used a coal-in-water slurry which was the first and the least economic method of pipelining coal. Costs per ton mile in transporting Alberta coal slugs to the Pacific in an oil pipeline would possibly be of the order of 0.4¢ per ton-mile. This compares with apparent costs of about 1.5¢ per ton-mile for the Ohio line. Even with highly efficient unit trains, it is very unlikely that Canadian railroads could meet this competition.

Many of coal's lost markets in the past fifteen years can be attributed at least partially to its relative immobility as compared with its competitor fuels. The following indices of relative transport costs for petroleum, natural gas, and coal on a B.T.U. basis were included in a submission to the 1959 Royal Commission on Energy:[16]

petroleum (by pipeline)	1
natural gas (by pipeline)	2.5
coal (by railroad)	6

Hence pipeline technology making possible the transport of Alberta natural gas to Vancouver via the Westcoast Transmission line or to Canada's industrial heartland via the Trans-Canada line considerably reduced the market for coal in these areas. Now further improvements in pipeline technology may enable coal to recapture some of those markets and win new ones. Advances in the pipelining of coal are necessitating a complete re-examination of the economic feasibility of developing coalfields in Alberta. For example the R.C.A. survey of the province's deposits of plains coal was originally concentrated in areas which were deemed to be potentially attractive for industrial

---

[16]Canada, Royal Commission on Energy, Submission by the Coal Operators' Association of Western Canada and the Western Canada Coal Utilization Council, Regina, April, 1959, p. 43.

location. However, advances in the pipelining of solids coupled with continuing price increases of oil and natural gas have now made it desirable to carry out a complete ". . . inventory of the strippable coal reserves of the whole plains regions regardless of location or present economic suitability."[17]

C. The Japanese Market.

The ability of Alberta operators to compete in Japanese markets would be much improved were coal pipelining to be used. An investigation has been carried out on the costs involved in pipelining coal from Alberta's Smoky River coalfield to Prince Rupert for export to Japan. The study was based on a 500 mile long, 14 inch pipeline involving annually the shipment of two million tons of coal in a similar quantity of oil. Transport costs per ton mile would be about one quarter of those of the well-known but short-lived line from Cadiz, Ohio, to Cleveland.[18] The costs of shipping coal from Alberta to the Pacific coast would be much lower than those presently encountered in rail shipping. The savings would enable Alberta operators to reach Japanese markets without benefit of a federal subsidy. The advantage of the pipeline over the railroad would be particularly marked in this instance because of the nature of the terrain. Despite the rugged topography, a pipeline from the Smoky River to the Pacific could be routed almost directly whereas in

---

[17] J. D. Campbell and I. S. Almadi, Coal Occurrences of the Vulcan-Gleichen Area of Alberta, Edmonton, 1964, p. 2.

[18] Pers. comm., N. Berkowitz, Edmonton, May 17, 1965.

mountainous areas, railroads are forced to follow very circuitous and therefore very costly routes.

D. The Ontario Market.

Pipelines could also enable Alberta coal producers to gain a significant share of the Ontario market which has been their goal for more than forty years. Ontario Hydro may well be consuming 25 million tons annually in its thermal stations in the Toronto area by 1985. Coal moving to this market from Alberta via pipeline could be delivered at lower prices than those currently commanded by American coal producers. The pipeline's cost advantage over the railroads would not be as great as it would be in the case of coal moving between Alberta and the Pacific because of the generally easier terrain between Alberta and Toronto. However, some of the difference would be made up due to the greater quantities involved in movement eastwards. A 24 inch pipeline would be justified rather than the 14 inch line suggested for shipments to the Pacific coast. Annual movement of five million tons to Ontario appears to be technically feasible and may prove to be economically possible.

E. Coal Pipelines and Industrial Location.

The use of coal pipelines could have a considerable effect on the locational patterns of thermal power stations. Current thinking holds that a coalfield should have a forty year reserve at a rate of 2,500,000 tons per year in order to justify construction of a thermal station on the coalfield itself. As such optimum fields are exhausted it should prove feasible to locate a power plant between several smaller

fields. Pipelines could very efficiently move large coal tonnages comparatively short distances of the order of fifty miles to the centrally located thermal station.

Coal pipelines could also bring about changes in the traditional locational pattern of the carbochemical industries. Efficient, low-cost means of moving large coal tonnages from Alberta to Canada's industrial centers in the St. Lawrence Lowland could give rise to carbochemical industries there just as movement of oil and natural gas by pipeline has aided the growth of petrochemical industries in the same region.

F. The Future for Coal Pipelines.

The first actual demonstration of the practicality of moving solid capsules in pipelines of commercial size was carried out by the R.C.A. in March, 1965. A 514 pound capsule moved with the regular flow of oil for 109 miles through the twenty inch line of Interprovincial Pipe Line Company Limited. Despite this success, however, the sought-after federal aid to ensure continued work in this aspect of research is still under consideration. It would appear then that the major obstacles to be overcome in development of coal pipelines are of a political nature. Until these can be circumvented, expected increases in coal markets dependent upon solids pipelining must still be regarded as somewhat visionary, at least for the immediate future.

CHAPTER VI

COAL AND ELECTRIC POWER GENERATION

I. The United States.

The market which will dominate the Alberta coal industry for probably at least a decade is that of electric power generation. As this trend becomes more pronounced, it will constitute yet another example of how the important patterns in Alberta's coal industry mirror those established earlier in the United States. The demand for electricity in the United States has grown rapidly in the past two decades and though the rate of increase is expected to level off somewhat before the turn of the century, the increase will still be very great in absolute terms (see Table XII).

To meet these growing demands for electricity, coal consumption for power generation will continue to increase rapidly and by 1975 is expected to account for about 60 per cent of the total American output. Over the period 1955-1975, the amount of coal consumed by this market is expected to increase by 170 per cent whereas the projected growth of all other markets over the same period is placed at only five per cent.[1]

II. Canada

Canada's demands for electricity in the next two decades will increase at an even faster rate than those of the U.S. During the twenty-five year period ending in 1980, Canada's overall generating capacity is expected to increase by more than five times.[2] The relative

---

[1]Schurr and Netschert, op. cit., p. 241.

[2]Davis, op. cit., p. 8.

TABLE XII[3]

GENERATION OF ELECTRICITY IN THE UNITED STATES
(IN BILLION KWH)

				Annual percentage growth rate in preceding decade
1940	182			--
1950	390			7.9
1960	845			8.0
	Estimates			
	low	medium	high	
1970	1,200	1,400	1,780	5.2
1980	1,710	2,230	3,090	4.8
1990	2,260	3,240	4,880	3.8
2000	2,970	4,710	7,770	3.8

[3]Landsberg, op. cit., p. 279.

importance of hydro power, however, will continue to be much higher than is the case in the U.S. The coal equivalent of the hydro power produced in Canada in 1963 was about 58 million tons, or considerably more than double Canada's actual consumption of all types of coal. Moreover, several more large scale hydro projects are currently under construction in Canada or are being planned. These include works on the Peace, Nelson, Churchill (Labrador), Manicouagan and Outardes Rivers, all of which have larger potential generating capacities than Grand Coulee Dam.

Yet despite this continuing growth of hydro power, thermal generating capacity in Canada will in all likelihood grow at an even faster pace. Thermal stations accounted for only 13 per cent of the country's capacity in 1955. By 1980 the figure is expected to be 28 per cent.[4]

Coal has been rather insignificant in Canada's generation of electric power in the past. As recently as 1953 the total coal consumption by Canada's leading twenty-six steam plants was 1,887,000 tons.[5] It is expected that this figure will be exceeded by the Wabamun plant alone in 1969.[6] Canada's thermal stations are expected to consume about 40,000,000 tons of coal in 1985, or over 60 per cent of all the coal used in Canada. Currently electric power generation accounts for only 20 per cent of the country's coal consumption.

---

[4]Davis, op. cit., p. 8.

[5]C. E. Baltzer, "The Canadian Power Situation with Particular Reference to Thermal-Electric Power", Transactions of the Canadian Institute of Mining and Metallurgy, vol. 61, 1958, p. 37.

[6]Stanley, op. cit.

III. Alberta.

A. Growth Rates of Power Generation and Coal Consumption.

When Alberta is considered alone, the growth in power generation and in coal consumption for power generation is still more impressive. The rate of increase in demand for electric power is much above the national average. The province's capacity in 1960 was 917,000 kilowatts. At the end of 1965 it was about 1,400,000 kilowatts, and by 1970 it may exceed 2,500,000 kilowatts. Alberta's power consumption is now increasing at about 14 per cent per year, about double the national average. It should also be noted that all projections made in the past concerning Alberta's load growth have eventually proved to be extremely conservative. For example in 1951 Alberta's load was about 250,000 kilowatts. In the report of the Alberta Power Commission published in that year, it was estimated that the load in 1960 would be 620,000 kilowatts. This was accompanied by the somewhat apologetic comment that, "This . . . almost looks like a preposterous estimate."[7] In actuality it proved to be highly conservative, with Alberta's 1960 load being 719,000 kilowatts.

It is expected that coal will play the dominant role in the expansion of Alberta's generating capacity in the immediate future. Whereas in 1955, coal was the source of only three per cent of the province's power output, it now accounts for 20 per cent and by 1980 will go to produce more than 60 per cent of Alberta's output. In

---

[7]Alberta, Annual Report of the Alberta Power Commission, Edmonton, 1951, p. 67.

absolute terms this means that the mount of coal consumed in power generation in Alberta will rise from about 1,000,000 tons in 1965 to 3,000,000 tons in 1970, and 6,300,000 tons in 1980.[8] As recently as 1963 the figure was only 350,000 tons.

B. Power Generation from Other Sources.

1. Oil and Natural Gas. This dominance of coal in the production of electric power will reverse a trend which persisted for ten to fifteen years following World War II. During that time the fuels to make the greatest advances in thermal power generation in both the United States and Canada were oil and natural gas. In 1957 natural gas was the fuel for more than 80 per cent of Alberta's thermal capacity. However between 1965 and 1980 the electric power output from coal-fired generators in Alberta is expected to increase by more than three times whereas the corresponding increase for natural gas will be less than 1.5 times.[9] By 1980 gas is expected to account for only 17 per cent of Alberta's electrical power output compared to 59 per cent in 1964.

There are several reasons why coal will be pre-eminent in the expansion of thermal power facilities in Alberta in the immediate future. Technological advances have been important, particularly in the fields of coal-fired generating equipment and in the pulverization of coal, facilitating automation of operations.

With these technological improvements, coal-fired plants are as efficient as those utilizing oil or natural gas. However,

---

[8]The Financial Post, 23 October, 1965.

[9]Pers. comm., J. G. MacGregor, Edmonton, March 2, 1965.

though operating costs are comparatively lower in a coal-fired plant, the fixed or capital costs are higher. Approximate figures for capital costs of thermal stations are as follows:

(i) coal-burning : $150 per kilowatt of installed capacity.

(ii) oil-burning : $145 per kilowatt of installed capacity.

(iii) gas-burning : $120 per kilowatt of installed capacity.[10]

The major reason for the increasing emphasis on coal, however, is a general concensus of opinion that the well-head cost of oil and natural gas will rise markedly during the next few years as large-scale exports force up prices. A similar trend is already well established in Texas. Meanwhile it is expected that with the widespread utilization of mechanized mining techniques, particularly in stripping operations, the cost of coal in Alberta should remain relatively stable for a long period of time. This is of critical importance to electric utilities since their service is generally sold under long-term contracts.

Related to the large-scale exports and consequently rising prices for natural gas, is the question of gas conservation. It is felt in some quarters that consumption of natural gas for power generation in Alberta should be restricted, reserving such an easily transportable fuel for export and for household consumers. The possibility of such restrictions being implemented was one factor in

---

[10] *Loc. cit.*

Calgary Power's decision to concentrate on coal in its thermal operations.[11]

However, although the emphasis in Alberta will be on coal to an increasing degree, gas will continue to be an important part of the overall power picture. In isolated areas where the load is small, the scale of operations is not large enough to justify the greater capital costs involved in coal-fired units. Similarly even when a new plant is constructed in close proximity to a comparatively heavily populated and industrialized area, it may be more economic to utilize gas during the initial phases of operations. For example until a new coal mine has been fully developed and is operating so as to obtain the economies coincident with large scale, it is often prudent to utilize gas as a source of fuel for a thermal station. This was the case at Wabamun. In 1962 when only one coal-fired unit was operating and the mine was still in the development stage, the cost of coal was 17¢ per million B.T.U.s. Two units remained on gas, available at 15¢ per million B.T.U.s. After the mine was more fully developed, the unit cost of coal declined and another unit was converted to coal. Units added in the future also will use coal.

2. Hydro Power. The growing importance of coal in the generation of electric power in Canada is somewhat surprising to many people. "The average Canadian . . . is fully convinced that all hydro power is cheap and all thermal power dear. In his

---

[11]M. M. Williams and C. F. Doerr, op. cit.

opinion, steam-electric power is outmoded, and positively antiquated if it must be produced from coal."[12] This allegation is well-founded. Hydro power has been dominant in Canada in the past. This tradition plus the existence of the widely held dictum that water is free has led many people to overestimate hydropower's importance to Canada. Despite significant technological advances in coal mining and in coal-fired generation of power, many Canadians have failed to recognize the growing importance of coal in this context. The failure unfortunately has not been restricted to "the average Canadian". The 1946 Carroll Royal Commission contained the following statement concerning power production in Alberta: "The possibility that coal may, in the near future, capture a much larger share of the electricity market than it presently holds is therefore considered to be remote."[13] More surprising is Davis' statement, written in 1957, that by 1980 ". . . electricity from thermal sources may be more than competitive on the Prairies."[14] Thermal power has been competitive in major sectors of the Prairies for decades.

Thermal stations have several important advantages over hydro stations. A thermal plant can be located at the market. Initial capital requirements are much less, with fixed charges per kilowatt of capacity about half as great for thermal stations as for hydro

---

[12]Baltzer, op. cit., p. 35.

[13]Canada, Report of the Royal Commission on Coal, 1946, Ottawa, 1947, p. 450.

[14]Davis, op. cit., p. 68.

stations. Moreover a thermal station can be built in stages, with new generating units easily added as the regional load grows. In contrast, it is very difficult to build a hydro station in stages. The entire project must be completed in one step with the result that much costly capital may lie idle for years until demand for power grows to the point where it can be fully utilized.

For these reasons the importance of thermal power in Alberta has increased greatly within the past decade and no major changes in the trend are seen in the immediate future (see Table XIII).

Although it is no longer dominant, hydro power is still very significant in Alberta as indicated in Table XIII. Two new large hydro projects are tentatively scheduled for completion before 1980. The first would be on the Athabaska River and is planned for 1972. The second, much less definite, would probably be completed about 1978 either on the Athabaska, the Smoky, or the North Saskatchewan. These possible developments are the reasons for the increases in hydro power's share of the total output in 1972 and 1980 as noted by asterisks in the table.

The production of electric power in Alberta today effectively combines thermal and hydro resources. Alberta's streamflow régimes vary greatly with the seasons, with the result that it is impractical to depend on hydro power facilities as a year round source of energy. However when hydro and thermal systems are interconnected, it is very efficient to utilize stored water when power demands are at their peak. Meanwhile thermal stations are oriented to the base load

TABLE XIII[15]

POWER GENERATION IN ALBERTA BY PER CENT OF SOURCE

	Hydro Power	Thermal Power
1942	57.7	42.3
1947	62.7	37.3
1952	64.8	35.2
1957	35.9	64.1
1962	25.4	74.6
1964	19.5	80.5
Estimates		
1967	20.0	80.0
1972	29.0*	71.0
1977	19.1	80.9
1980	22.9**	77.1

[15]Pers. Comm., J. G. MacGregor, Edmonton, March 2, 1965.

and therefore account for most of the power produced in the province, or close to 80 per cent.

3. Nuclear Power. The fact that coal is expected to dominate Alberta's thermal power production in the immediate future is one of the chief reasons for the increasing optimism in the coal industry. However the optimism should be tempered somewhat in this particular instance. Overdependency on the electric utility market could have serious consequences should coal lose its present economic advantages in the field.

Since 1945 research has been carried out in several countries in attempts to develop practical, non-military uses for atomic energy. At the present time the utilization of atomic energy still entails the use of very cumbersome and costly containing apparatus which effectively eliminates nuclear power as an economical motive fuel for land transport. Nuclear power thus poses little threat to oil's position. However it is well-suited to use in thermal power stations, and it is in this area that the impact of nuclear power is first being felt in the commercial world. Such power is now being produced in the eastern United States for about 25¢ per million B.T.U.s. At Alberta's two most efficient coal-fired generating stations, power is produced for only 10¢-12¢ per million B.T.U.s. However the gap between these two figures could diminish if continuing research brings about greater economies in nuclear power generation. Moreover as new power plants are needed in Alberta, it will become necessary to utilize sites and coalfields where conditions are slightly less attractive than those at Wabamun and Forestburg. Hence the costs

of coal-generated power will slowly rise until the point is reached where nuclear power becomes competitive in Alberta. This point could possibly be reached by 1985.[16] Thus, although coal's position in the power field seems secure for one or two decades, nuclear power may have reduced its markets considerably by the turn of the century.

Granting, therefore, that the most favorable sites for utilization of plains coal will still be fully utilized, it would appear to be safe to assume that the competition of nuclear power will rule out large scale use of the bituminous mountain coals for power generation. The rumored power plant for the Crowsnest Pass would thus seem to have little chance of materializing, particularly since the imminent full-scale development of the Columbia has reduced greatly the opportunities for exports to adjacent areas of the United States.

4. The Athabaska Tarsands. Possibly an even greater threat than nuclear power to coal's domination of Alberta's power production in the immediate future is posed by development of the Athabaska Tarsands. Fuel from Fort McMurray will be piped to the Edmonton district in quantity by 1968-70 at which time it may well be possible to produce electric power from it for 17¢-18¢ per million B.T.U.s. Tarsands power should thus be fully competitive in the populated areas of Alberta considerably earlier than nuclear power.

5. The Future for Alberta Coal in Power Generation. Considering the competitive possibilities of all these alternate

---

[16] Pers. comm., J. G. MacGregor, Edmonton, March 2, 1965.

energy sources, it would be imprudent for the coal industry of Alberta to depend excessively on the power generation market much beyond 1975. Moreover, as technological improvements are made in coal-fired power generation itself, the result will be increased efficiency and therefore less coal will be required to produce a given amount of power. When central generating stations first appeared in the late nineteenth century, ten pounds of coal were needed to produce one KWH of electricity. By 1900 only seven pounds of coal were required, and by 1920 only three pounds. As recently as 1952, one KWH required 1.3 pounds of coal. Today that figure has again been halved.[17] Thus even as coal maintains markets in power generation, it will do so only with reduced tonnages per unit of power produced.

C. Coal-fired Power Stations in Alberta.

Despite the uncertainties involved in it after 1975, the electric utility market has been one of the major saving factors for Alberta's coal industry during the present decade. The two leading coal areas of the plains, Pembina and Castor, are each oriented toward a large thermal station (see Figs. 4 & 6).

1. Locational Factors. Several locational factors are involved in the establishment of such a coal-fired station. Obviously the location of suitable coal is of paramount importance, since fuel costs can amount to one half of the overall costs. For any power operation, excluding those of extremely small scale, it is

---

[17] Laffen, op. cit., p. 96.

Baltzer, op. cit., p. 36.

more economical to transport the electrical energy than the raw coal. Hence the tendency is to locate the station at the source of the raw material, i.e., on the coalfield. To justify a large scale power plant, the minimum reserve necessary is generally deemed to be approximately 50,000,000 tons. Such a reserve would permit the station to build up to a capacity of at least 600,000 kilowatts within ten years and to operate at the ultimate capacity for at least another thirty years.[18] Since labor is one of the main cost items in coal mining, it is desirable too that this coal reserve be suitable for mechanized stripping techniques. It is not surprising that few coalfields meet such a set of conditions. Two research workers involved in R.C.A.'s borehole survey to inventory the province's coal reserves concluded that "It appears that few considerable bodies of strip-coal remain to be discovered in the prairie regions of Alberta."[19]

Although under present economic conditions in Alberta, it is economical for coal-fired plants to be raw material oriented, it is still obviously desirable that they be as close as possible to the market or load center. Transmission costs are then minimized. An

---

[18]Pers. comm., J. G. MacGregor, Edmonton, March 2, 1965.

[19]Campbell and Almadi, op. cit., p. 1.

adequate labor supply for the entire mining and power generation complex is also desirable, as are rail and road access and other aspects of the regional infrastructure.

One key locational factor for a large thermal station is an adequate, dependable water supply to provide the necessary coolant for the condensers. This is a critical problem on the prairies where so many demands are made on a limited amount of water. An official of Calgary Power wrote that "In the plains region of the Prairie provinces, the problem of cooling water supply may well be the major determining factor in the location of a [thermal power] plant."[20]

The amount of water needed is quite considerable. Even for a relatively small plant of 100,000 kilowatt capacity, the cooling water requirements are 108 cubic feet per second. If such a plant is to be located on a lake, a surface of one square mile is necessary to dissipate the heat taken on by the coolant.[21]

The lack of a water supply capable of meeting these needs has so far prevented the establishment of a thermal station utilizing the large strippable coal deposits in the Hanna and Sheerness districts.

Continuing research in the field of air-cooled condensers may reduce the importance of a cooling water supply as a locational

---

[20]M. M. Williams, "Coal in Western Canada and Its Uses", Transactions of the Canadian Institute of Mining and Metallurgy, vol. 61, 1958, p. 246.

[21]J. A. Harle, "Thermal Power for Alberta", Transactions of the Canadian Institute of Mining and Metallurgy, vol. 54, 1951, p. 449.

factor. Should this occur it is probable that a plant utilizing the Hanna-Sheerness deposits will ultimately supply much of the power used in the Calgary area.

There are presently four coal-fired thermal stations in Alberta. The two largest ones, Wabamun and Battle River, were begun in the 1950s and illustrate well the importance of large strippable reserves, cooling water, market, and labor supply as locational factors. The other two stations, Drumheller and Sentinel, are much smaller and have much longer histories. Economic conditions have changed considerably since they were first built, with the result that they are not as favorably located today as the recently established plants at Wabamun and Battle River.

2. Drumheller Power Station. The first power plant in Drumheller, built in 1916, had one unit with a capacity of twenty-five horsepower. The station now has a capacity of 17,500 kilowatts or 23,300 horsepower. The plant consumes 60,000 to 85,000 tons of coal per year, depending upon the severity of the winter and upon the economics involved in the operation of Canadian Utilities' entire grid. Drumheller's output is secondary to that of the more economical generating facilities at Battle River. Hence it is preferable to maximize Battle River's output with a corresponding decrease in Drumheller's output. In 1964 when total coal consumption at the Drumheller plant was about 67,000 tons the sources of supply were as follows:

1) Amalgamated Coals

--East Coulee mine (underground)..... 40,000

--Utility Coal Strip Mine..... 25,000

2) Subway Coal (Strip)..... 2,000

3. Sentinel Power Station. The Sentinel thermal station (see Fig. 7) of East Kootenay Power Company was built in 1926 with an original capacity of 5,000 kilowatts. The capacity was doubled in 1928 but no expansion has occurred since. Like the Drumheller plant, it was built decades ago in close proximity to a major underground mining district. Conditions are now vastly different. Mining costs are higher in the Crowsnest than on the plains, the water supply is inadequate, and markets in the immediate area are lacking.

4. Possible Locations for Coal-fired Power Stations. In contrast to a long established thermal station such as Sentinel, which is now unfavorably located, there are a number of general localities in Alberta which could offer favorable sites for such stations. Professor Harle has noted eight such "localities" in the populated area of Alberta. Significantly all are either lakes or rivers, indicating the over-riding importance of water for cooling purposes. The water bodies mentioned are Pigeon Lake and Lake Wabamun, plus six rivers--the Pembina, North Saskatchewan, Red Deer, Bow, Oldman, and Milk.[22] (see Fig. 4).

---

[22] Loc. cit.

5. Additions to Edmonton's Power Generating Facilities. There has been a great deal of controversy recently regarding the type and location of generating facilities to be added to the existing gas-fired system of the City of Edmonton. Present capacity will be insufficient to serve the city's needs by 1969. Several courses of action have been under consideration with a view to meeting requirements beyond that date.

Until 1950, Edmonton's municipally owned power plant was the largest coal-fired station in the province. In the latter half of the 1940s, it consumed over 150,000 tons of coal annually, thus constituting a major market for the producers of the Edmonton coalfield. In 1950, however, economics dictated a conversion from coal to natural gas. The total capacity of the plant is now 330,000 kilowatts and another 75,000 kilowatt gas-fired unit is being added in 1966. Beyond that, however, expansion at the existing site is impracticable.

Since the conversion to natural gas in 1950, considerable advances have been made both in the strip mining of coal and in its use in thermal power generation. Hence much study has been done on the possibility of a large-scale coal-fired station becoming the basis of Edmonton's expansion plans. Accordingly the city acquired coal leases in 1960 in the Genesee area, about forty-five miles southwest of Edmonton (see Fig. 4). This coalfield has been known since 1886 when Tyrrell of the G.S.C. estimated its reserves at 140,000,000 tons.[23] Present estimates are 120-200 million mineable tons. Plans

---

[23] J. B. Tyrrell, "Report on a Part of Northern Alberta and Adjacent Districts of Assiniboia and Saskatchewan", Annual Report, G.S.C., 1886, vol. II, Part E., p. 148.

formulated in the early 1960s called for construction of a 150,000 kilowatt unit on this coalfield by 1969, with an ultimate capacity of 600,000 kilowatts by 1979.

Then, later in 1964, plans for development of the Genesee field were stalled when a proposal was made for a joint power development by the cities of Edmonton, Calgary, and Red Deer. The basis of the project was to be the Ardley coalfield, twenty miles east of Red Deer (see Fig. 3). When the proposal was first made in December, 1964, Ardley's reserves were cited at 300-600 million recoverable tons. In January, 1965, Dynamic Power Corporation of Calgary, would-be developers of the project, announced that reserves were at least one billion tons. In May the firm released a thorough geological report giving Ardley's reserves as 200,000,000 recoverable tons with only 15 per cent of the field studied.

However, though the quantity of the coal has never been questioned, there have been serious doubts concerning its quality. Calgary Power considered Ardley more than a decade ago, but rejected it in favor of Wabamun. Two R.C.A. officials found serious faults with the geological report released under the auspices of Dynamic Power. Ardley's coal measures consist partly of coal lenses in shale strata. If this entire section were utilized the ash content would be 10-30 per cent and the B.T.U. value only 5,500-6,000, considerably less than the value of 7,000-7,600 given in the report. In essence, the R.C.A. rejected the conclusion of Dynamic Power that a thermal power station based on Ardley coal was an economic proposition.

In the aftermath of the controversy, Edmonton has now rejected both Ardley and Genesee. The plan recommended in November, 1965, by Superintendent Kirkland of the city's power plant calls for a new gas-fired complex with two 165,000 kilowatt units, the first of which will be in operation by 1970.

The proposed new gas-fired plant will be market oriented, located on Edmonton's outskirts. Had Ardley and Genesee materialized, they would have been located at the source of the fuel or raw material. Even then, however, the market would not be very far distant.

6. A National Power Grid. It is possible that a new pattern may develop in the near future, whereby coal-fired plants are definitely raw material oriented, supplying power to major load centers one thousand and more miles distant. Ever-increasing improvements in the transmission of electrical energy could make this practicable. At the end of World War II, economic transmission of electricity was restricted to little more than 200 miles. Now through the use of extra high voltage (EHV) transmission lines, electricity can be practicably transported 750 or 1,000 miles, with further improvements expected which would increase this distance even more. Minehead power plants in Alberta could thus meet some of the great electricity demands of regions like southern California or the St. Lawrence Lowland.

Advances in EHV transmission have prompted studies on the feasibility of a national power grid in Canada. There are advantages to the operation of such a grid. It would permit optimum use of low cost energy resources such as the large strippable coal reserves of the Alberta plains. The existence in Canada of five major time zones could be used to good advantage. Interconnected power systems would profit from the "staggered" or displaced peaks across the country. Higher demands could thus be met with a lower aggregate capacity. It has been calculated that this saving in capacity would be 1,500,000 kilowatts.[24] The effect would be to operate the overall system with less idle capacity and therefore greater efficiency.

Five years ago there was considerable enthusiasm for a national grid. This has waned somewhat in the past several years. It is generally felt that a national grid is not needed at the present time. Power development in Canada has been mainly on a provincial basis since the administration of natural resources fell to the provinces in 1930. Moreover, most load centers, particularly in the West, are located near the centers of the respective provinces, with Edmonton, Saskatoon, and Winnipeg being examples. Under present conditions, interprovincial connections would thus not be utilized to a significant degree. However despite the reduced enthusiasm for immediate adoption of a national grid policy per se, it is still felt that such a grid will evolve in Canada.

---

[24] Cass-Beggs, D., "Economic Feasibility of Trans-Canada Electrical Interconnection", The Engineering Journal, vol. 44, no. 1, January 1961, p. 57.

A national grid would provide yet another means, in addition to the unit or integral train and the solids pipeline, by which Alberta coal would be used to supply part of the power demands of distant parts of Canada including British Columbia's Lower Mainland and industrial Ontario. Whether or not Alberta coal is used to supply these markets, will depend upon future changes in technology and how they affect the costs of the transportation and use of the various energy sources.

CHAPTER VII

SETTLEMENT AND LABOR PATTERNS

In direct contrast to the situation with respect to petroleum, the existence of coal in Alberta has been known for nearly two hundred years. The earliest recorded references to these deposits were made by employees of the Hudson's Bay Company (H.B.C.) in the late eighteenth century. During the nineteenth century more detailed information pertaining to Alberta's coalfields was made available as a result of the work of government sponsored expeditions and later of the reports by members of the G.S.C. These reports to some extent influenced the settlement of Alberta, since prospective immigrants were encouraged by the news of abundant coal in a region where timber, as a source of fuel, was relatively scarce.

I. Discovery of Alberta Coal Deposits.

The man generally regarded to have first recorded the existence of coal in Alberta was Edward Umfreville. During the latter 1780s, he was in charge of the upper-most post maintained by the North West Company on the North Saskatchewan River. He published a book in 1790 in which he referred to ". . . the great quantity of Coal conveyed down by the current."[1] However Umfreville did not record the location of any actual Alberta coal deposit. The first to do so was Peter Fidler, a surveyor for the H.B.C. In 1791-93, he noted the deposits in the Red Deer River valley, near the mouth of Rosebud Creek.[2] About

---

[1]John Warkentin, The Western Interior of Canada, Toronto, 1964, p. 73.

[2]Over a century later this coalfield was to become the basis of the thriving Drumheller mining district.

the same time Alexander Mackenzie recorded the existence of coal seams on the banks of the Peace River near the point where it crosses the present boundary between Alberta and British Columbia.

The first reference to the coals of the Edmonton Coal Area was made by David Thompson of the North West Company. He noted outcrops along the banks of the North Saskatchewan River while journeying downstream from Rocky Mountain House in 1800. The location was about seventy miles southwest of Edmonton.

In 1857 an expedition sponsored by the British government and the Royal Geographical Society arrived in Fort William, Ontario. During the next three years this group, led by Captain John Palliser, carried out a general geographical survey of the southern reaches of that part of British North America lying between the Great Lakes and the Rocky Mountains. It was specifically stated in Palliser's instructions that he record ". . . any indications of coal or other minerals."[3] Accordingly he drew attention to the coal deposits which later gave rise to Canmore and Anthracite, deposits first discovered about 1845. One of Palliser's subordinates, Lieut. Blakiston, was the first to record the rich Crowsnest Pass deposits.

The leading figure in the expedition's scientific work, however, was James Hector. He was responsible for the original discovery or first detailed studies of many of Alberta's most important coalfields. The now controversial Ardley field was reported in 1858 and the Lethbridge field in 1859. In 1860 Hector moved west from Edmonton, reporting on coal seams in the Pembina and Athabaska River Valleys, deposits which later gave rise to the settlements of

---

[3] Warkentin, op. cit., p. 156.

Entwistle, Brûlé and Pocahontas. Later he discovered the rich Big Horn and Brazeau fields of the Nordegg district, and the Ribbon Creek deposits south of Canmore (see Figs. 2, 4, & 10).

In 1873 the G.S.C. extended its operations to western Canada and for nearly half a century most of the important studies on Alberta's coalfields were the work of its scientists. In that first year A.R.C. Selwyn travelled down the North Saskatchewan recording the locations of coal seams in more precise fashion than had ever been done before. He concentrated particularly on coals of the Edmonton district and initiated the use of the term "Edmonton Formation".

George M. Dawson, later the Director of the G.S.C. himself, did considerable work on the coalfields of southern Alberta. In 1875 he originated the use of the term Belly River Formation. Subsequent studies dealt with the bituminous coal deposits of the mountains south of the Bow River, including those of the Oldman, Crowsnest, Highwood, and Kananaskis valleys in addition to those of the Bow valley itself (see Figs. 3 & 4).

Much useful work on the coal deposits of central Alberta was done by J. B. Tyrrell in the mid-1880s. He did detailed studies on the Edmonton coalfield, and was the first to record the existence of the coal deposits of the Battle River valley, which now supply fuel to a large thermal station.

After it became apparent in the late nineteenth century that a second and more northerly railroad line was to be built through

the Canadian west, the G.S.C. emphasized coal studies along its tentative route. Accordingly in 1897 James McEvoy undertook a cursory examination of major deposits between Edmonton and Tête Jaune Cache in British Columbia.

Probably the most voluminous of the G.S.C. studies relating to Alberta coal deposits were those of D. B. Dowling. For nearly forty years beginning in the mid-1880s he travelled through the wilderness, studying the deposits of the Bow, Cascade, upper North Saskatchewan, and Brazeau Rivers, as well as those of Jasper Park.

II. The Coal Industry and Rural Settlement.

Publication of the G.S.C. reports was of some importance in attracting settlers to the Alberta plains since a dependable fuel source was then assured. There was a two way relationship between coal and rural settlement . Just as coal deposits helped stimulate settlement, so rural settlement was responsible for the discovery of many new coal deposits. A vital commodity on the plains was water. The drilling of wells by the farmers in their continual search for water often revealed the existence of previously unknown coal deposits.

The inter-relationship between coal and agriculture has been an important and interesting one in Alberta's history. Traditionally there was a large number of extremely small scale mining operations located in outlying agricultural districts. These wagon mines, so called because they lacked rail access, provided fuel for the farmers of the immediate area. Recovery rates were generally low, but overhead expenses were almost non-existent, and the wagon

mines persisted. They often provoked angry criticism, however, from major coal operators genuinely attempting to conduct large scale operations with a minimum wastage of resources. These larger firms claimed, with some justification, that the wagon mines were a source of unfair competition.

The number of wagon mines in Alberta today is much less than it was during the 1930s (see Figs. 22 & 23) due to the highly successful rural electrification program and the ready availability of fuel oil and natural gas in many rural areas.

III. The Character of Coal Mining Centers on the Plains.

The coincidence of coal mining and agriculture on the Alberta plains is possible because coal is found in sedimentary rock. This sets coal apart from the metallic minerals which are generally associated with igneous bedrock and are therefore usually found in shield or mountain regions unsuited to agriculture. Coal and the other fossil fuels, however, are associated with sedimentary basin geology and thus often occur in plains locations where agriculture is easily pursued.

As a result, coal mining on the Alberta plains rarely spawned regional centers which bore the unmistakeable stamp of a mining community like those of the metal-mining region of north-eastern Ontario.

Drumheller is a useful example. It has been the regional capital of an important coal mining district for more than fifty

years. At the peak of mining activity in the early 1930s, there were 24-26 mines operating in the district, each employing 80-150 persons. Even as late as 1949, there were still more than twenty mines (see Fig. 22). Then came the trying period of the 1950s and the collapse of the domestic fuel market. With the closing of the Red Deer Valley mine in 1958 and the Hy-Grade mine in 1962, Amalgamated Coal's mine at East Coulee is now the only major mine still operating in the district (see Plate V and Fig. 9).

Despite this rapid decline of its leading industry, however, Drumheller has survived. This is an indication that coal never completely dominated the economy to the virtual exclusion of other industries as was the case in centers like Cadomin and Nordegg. Admittedly Drumheller suffered a serious setback with the decline of coal. There was a definite trough in business activity in 1959. However there was no noticeable decline in population. In fact the population of Drumheller proper has grown since the 1930s and now stands at about 3,400.[4] The town is now dependent mainly on agriculture and to a lesser but growing extent on tourism. Its role as a regional center is becoming more evident, with the establishment of new service industries such as finance.

However, though Drumheller itself has weathered the storm, its satellites have fared less well. During the period of early mining development, agglomerated settlements grew up around each new

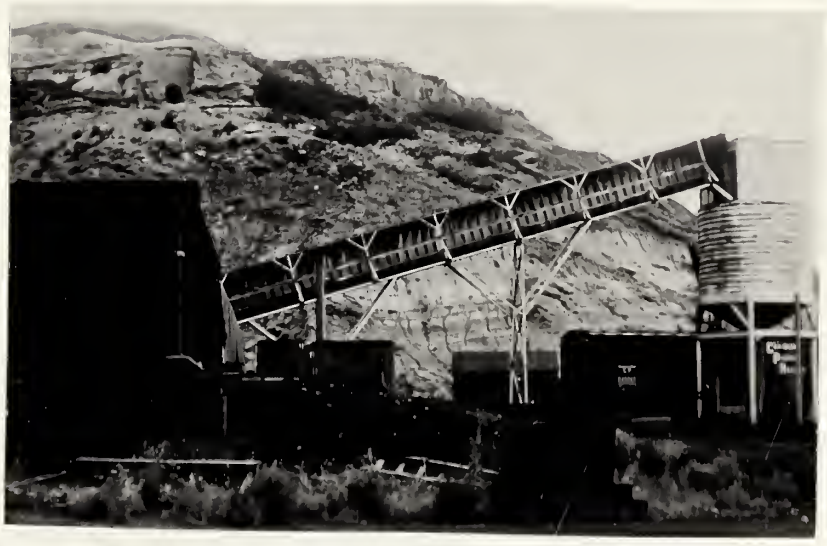
---

[4]Pers. comm., M. Danyluk, Drumheller, Aug. 5, 1965.

PLATE V

MINES IN THE DRUMHELLER COAL AREA

Abandoned Mine,
Murray Collieries, East Coulee



Amalgamated Coals, East Coulee

This is the only major mine still operating in the Drumheller Coal Area, and is the largest underground mine in the plains region.

mine as it came into production. Nacmine, Newcastle Mine, Midlandvale, Rosedale, and Wayne are examples of such mine villages. Together with Drumheller, they had a total population in the 1930s of about 12,000. Today, however, although the population of Drumheller proper has increased since that time, the population of the district as a whole has declined to about 8,500. Obviously the satellite villages have suffered greatly. Unlike Drumheller, they were almost totally dependent on the coal industry. Service industries were virtually non-existent. Besides mining, the only function served by these settlements was the residential one. When the mines were abandoned there was no longer any reason to maintain residence in the satellite villages, and their populations often declined by 90 per cent (see Plate VI).

Naturally there were hardships for those persons who were forced to seek homes and employment elsewhere. Yet the difficulties were not overwhelming. Most of the plains area was populated, and alternate types of employment were often available. Some miners were absorbed by the growing construction industry, and a good many shifted easily into the rapidly expanding oil and gas industry whose growth had contributed heavily to coal's decline. Perhaps the most important factor in easing the problems of the unemployed miners from Drumheller and other mining districts of the plains was that they were accustomed to seeking alternative employment every year, given the extreme seasonal fluctuation of coal mining in the plains region.

IV. Seasonality of the Plains Mines.

A. Pre-war Conditions.

This marked seasonality was a distinguishing characteristic

PLATE VI.

SETTLEMENT FEATURES IN THE DRUMHELLER COAL AREA

WAYNE

This community is five miles south of Drumheller. Between 1950 and 1965 its population declined from about 1,000 persons to about 100 persons.

COMPANY TOWN

Some of these residences, part of an old company town, are still inhabited. The site is at East Coulee, about twelve miles southeast of Drumheller.

of coal mining on the plains from its inception until World War II. Many of the mines closed down almost entirely for six months every year, beginning usually in February and re-opening in the following August or September. For those mines which attempted to remain in operation all year round, the trough in employment usually came in June, with the peak occurring in December. Even in these mines which did produce all year round, operations were still distinctly seasonal. Kleenbirn Collieries at Eyremore, about twenty-five miles west of Brooks (see Fig. 2), averaged about 950 tons per shift in the summer and about 1,800 tons in the winter. This variation was reflected in the rail communications to Eyremore, located at the end of a C.P.R. branch line. From September to March there was daily service, but from April to August there were only three trains per week.

Given that seasonality was a characteristic feature of the plains maines, operations could have been adapted to facilitate production according to a regular seasonal curve. However the situation was even more difficult, for although there was usually a trough in spring and a peak in winter, production was very erratic, with working days scattered through any given month. Such irregular operation meant that seasonal migration of labor was only a partial solution.

It is therefore important to realize that although total employment in Alberta's coal mines has fallen sharply in the past twenty years, many of those employed in earlier times had minimal job security due to the seasonality of operations. The 1920s were a boom period for the coal industry, yet the plains mines rarely operated at more than 80 per cent of capacity for more than one third of the

working days in a year. The figures in Table XIV pertain to the sub-bituminous mines of the Pembina, Edmonton, Tofield, and Camrose Coal Areas (see Fig. 3).

During the depression years of the early 1930s, the situation became even worse in Alberta's sub-bituminous fields. (See Table XV). Thus in 1931 when it was considered desirable that a man work 250 shifts annually, 68 per cent of the persons employed in the mines in these four major producing areas, worked less than 100 shifts.

Seasonal operations led to hardships not only for employees, but also for management. The long periods of inactivity made the mines exceedingly costly concerns since fixed costs remained in effect whether or not the mine was producing. Such costs include taxes, rentals, and maintenance, the latter being a major item since it is essential that constant attention be given to pumping and timbering in order that the mine might be brought into production easily when markets develop.

The situation improved somewhat for Alberta's mines during World War II. Wartime demand resulted in a marked increase in the regularity of operations. This trend is reflected in the statistics of Table XV. Thus, whereas only six per cent of the men employed in this sampling of sub-bituminous mines worked 200 or more shifts in 1931, by 1944 the figure had risen to 47 per cent. Yet even the latter level is far from satisfactory.

B. The Post-War Period.

In the first decade after the war, the coal industry declined seriously. Not only had the wartime demand factor ceased

TABLE XIV[5]

PERCENTAGE OF CAPACITY USED IN REPRESENTATIVE PLAINS MINES, 1921, 1923, 1924

Percentage of full capacity	AVERAGE NUMBER OF DAYS WORKED		
	1921	1923	1924
81-100	100	108	129
61-80	39	25	21
41-60	59	46	29
21-40	18	23	11
1-20	8	69	35
Idle	84	88	86

[5]Alberta, Report of the Alberta Coal Commission, 1925, Edmonton, 1926, p. 81.

TABLE XV[6]

DISTRIBUTION OF SHIFTS WORKED, SAMPLE MINES
OF THE PLAINS REGION FOR SELECTED YEARS, 1931-1944

Year	Percentage of Men Working Given Number of Shifts			
	less than 100	100-199	200-299	more than 300
1931	68	26	6	---
1936	44	42	13	1
1939	47	39	13	1
1942	36	27	31	6
1944	31	22	42	5

[6]Canada, Report of the Royal Commission on Coal, 1946, Ottawa, 1947, p. 305.

to exist, but major pre-war peacetime markets also collapsed. Seasonal layoffs therefore increased greatly in number, and permanent discharges became common.

However, though the general situation was unpropitious, there were some favorable developments. Alberta's economy in the post-war period has become much more diversified and the sources of employment have increased accordingly. Those mines which managed to survive the trying transition period of the early 1950s often found it exceedingly difficult to operate on the same seasonal basis which had been so common in the past. If they had continued to close down entirely for six months, it would have been very difficult to maintain a labor force in the face of so many more sources of employment than ever before. The mines therefore began to utilize the summer months for the driving of entries and other similar tasks. They were then able to concentrate more fully on actual coal production as opposed to mine maintenance during the peak demand season. Admittedly there is still a substantial difference between the size of the labor force in summer and that of the winter. Amalgamated Coals of East Coulee is a good example. Its labor force varies from a winter peak of about 140 to a summer low of about 95. The significant point is, however, that the hard core of the labor force now has year-round employment. This was not typical of the Drumheller Coal Area before World War II.

The persistence of some degree of seasonality at Amalgamated Coals is due to the continued importance of the household fuel market.

One favorable post-war development in the sub-bituminous region of Alberta has been the establishment of major mining operations which do not dispose of the major part of their output in this highly seasonal market. These mines depend instead on sales to thermal power stations. The best example is the Whitewood Mine at Wabamun. The large guaranteed market provided by the power plant permits regular efficient use of men and machines throughout the year. Thus, unlike most of the plains mines including the old underground operations on the same site, Whitewood's rate of output remains fairly constant throughout the year.

The other major coal-fired thermal plant in Alberta is Canadian Utilities' Battle River Station which is supplied by Forestburg Collieries and Battle River Coal Company (see Plate I and Fig. 4). However, neither mine markets as much as half of its output to the power plant. In 1964 the combined output of the two mines was about 660,000 tons, with about 275,000 tons going to the power plant. The household fuel market is thus still a significant one for both mines (see Figs. 6 & 25). This is reflected in seasonal variations in the labor force. Battle River Coal Company's labor force varies between 28 and 45, and that of Forestburg Collieries between 35 and 50. This is a marked improvement, however, over the former situation when underground operations were carried out at the present sites of these two strip mines. Operations began on the south side of the river shortly after the end of World War I. This mine, usually known as the Cordel Mine, continued to produce until stripping

began in 1947. It employed about twelve persons in peak periods. Underground mining on the north side of the river dates back even further, to the first decade of the century. Up to twenty persons were employed at these workings which were abandoned after large scale stripping began in 1950. Each of these old underground mines was operated on a strictly seasonal basis, closing down for about six months every year.

V. Integration of Mining and Farm Labor.

Seasonality of the plains mines has long been regarded by some members of the work force as a distinctly desirable situation. A large number of men worked in the mines in the winter and farmed in the summer. Many were agricultural laborers, i.e., they did not own farms. Others, however, owned their own farms and returned to the same district mine to work every winter. This particular variation was especially common for the marginal farmers of the pioneer fringe such as those of the Pembina Coal Area who worked the old underground mines which preceded the present large scale strip mine. Another area where the general economy benefitted from the seasonality of the coal mines was the Lethbridge-Taber district. There much of the labor in the sugar beet industry was provided by men who mined in the winter.

This seasonal co-ordination of labor for the agricultural and mining industries often seemed, on the surface, to be a desirable and efficient system. Royal Commissions sometimes advocated that steps be taken to formally organize a seasonal migration of labor. However the "system" had many serious disadvantages. Family men had a particularly trying time since they found it much more difficult

to obtain farm work, and even if they were successful, the periodic moves were a hardship on a family. Moreover the coal and farming seasons were not completely separate. The mines often opened in the autumn before harvest and closed late in the winter or very early in the spring before the need for farm labor was very great. It should also be recalled that variations in mining production levels did not follow a regular seasonal pattern but instead were highly erratic, making seasonal migration of labor impractical. Finally a factor which is becoming increasingly important today is the mechanization of agriculture and consequently a reduced demand for farm labor.

Despite the difficulties in co-ordinating the labor demands of farm and mine, the practice is still important in some of Alberta's plains mines, including some of the largest and most efficient. Some employees of Battle River Coal Company's large strip mine regularly obtain leave of absence from April to September to work their farms. They leave the mine with no loss of seniority and some have been working on this basis for more than ten years, with the practice being mutually beneficial for both miner and management.

VI. The Effect of Coal Mining on Settlement in the Mountains.

The preceding discussion of the relationships between the coal industry on the one hand and patterns of settlement, labor, and employment on the other applies only to the plains region. Relationships in the mountain mining districts of western Alberta were very different.

On the plains, the existence of coal was of some importance in encouraging settlement. However its importance was definitely of

of a secondary nature. The settlers were primarily agriculturalists. For them the determining factors were the fertility of the soil, the easy terrain, and the lack of dense forest cover. The coal deposits were merely a much appreciated bonus.

In the mountain region, however, coal's relative importance was much greater. It was not an appreciated extra, but the dominant factor attracting settlement, and in some cases the only factor. From the beginning, the mountain coal was regarded as not merely a material to heat homes which were basically supported by other industries, but as the lifeblood of new communities.

A. Labor Requirements in the Mountain Mines.

It is important to recall that it is much more difficult to extract coal from the pitching seams of the mountain districts than from the relatively flat-lying seams of the plains [Chapter I]. Hence whereas the plains had attracted agricultural settlers who mined coal incidentally to heat their homes, the pitching seams of the mountain regions attracted men who were primarily miners, often highly skilled miners from coal-mining districts in many parts of Europe and the United States. England, Scotland, Wales, Italy, Russia, the Ukraine, France, Germany, Belgium, Slovakia, Poland, Serbia, and Austria were among the countries of origin of Alberta's immigrant miners. In 1911, over 90 per cent of those employed in Alberta's coal mines were born outside Canada.[7] Even as recently as 1941 one half of the province's coal miners were born in continental Europe, and

---

[7]Alberta, Report of the Alberta Coal Commission, 1925, Edmonton, 1926, p. 181.

another quarter were born in the British Isles.[8] Several mining districts in Alberta have a particularly high proportion of one immigrant group. For example, the Slavs are the dominant population group in the Crowsnest Pass area. Even the separate centers within the Pass reflect quite different ethnic structures. The Poles and Ukrainians are prominent in Coleman, the Slovaks in Bellevue, the Czechs in Frank and Blairmore (see Fig. 7). Blairmore also has a significant number of people who trace their origins to France and Belgium, reflecting the importance of French capital in the early development of West Canadian Collieries at Blairmore (see Fig. 7).

B. The Dominant Position of the Coal Industry.

A fact of considerable importance is that unlike the sub-bituminous mining areas of the plains, bituminous mining centers most often arose in parts of Alberta which had not been previously settled. Many of the bituminous mining communities thus became almost totally dependent upon coal. Alternative sources of employment were negligible.

It is particularly significant that one source of employment almost totally lacking in the mountain region was agriculture. In the early part of the century it was felt that development of coal mining in the foothills and mountains would help open up these areas for other economic pursuits. For example, Dowling, while referring to the coal deposits of the upper Saskatchewan and Brazeau River country, wrote as follows in 1907: "The development of mines in this district

---

[8]Canada, Report of the Royal Commission on Coal, 1946, Ottawa, 1947, p. 283.

will both extend settlement to another large fertile area west of the Saskatchewan and open up a large lumbering area."[9] This and similar statements proved to be visionary. For various reasons, agricultural settlement never became important in most of the leading bituminous mining districts such as the Crowsnest Pass, the upper Bow River, the Nordegg district, and the Coal Branch (see Figs. 2 & 4). Infertile soils, excessive slopes, and unfavorable climatic conditions precluded agriculture in these areas. Hence the mountain mining areas did not see the development of a close relationship between agriculture and coal mining as had occurred on the plains. The lack of alternative urban functions, notably that of service center for a regional agricultural industry, meant that the mountain mining communities definitely had the character of mining towns, unlike the centers of important mining districts on the plains such as Edmonton, Lethbridge, and Drumheller.

C. The Importance of Isolation.

Another factor which helped to emphasize the single function character of the mountain towns was isolation. Although all the important mines were necessarily served by railroads, many, such as those of the Coal Branch and the Nordegg district, were not accessible by all-weather road until the 1950s. The road and the private automobile are important socially in providing ready, inexpensive means of travel for individuals and their families.

---

[9]D. B. Dowling, "Explorations in the Rocky Mountains", Summ. Report, G.S.C., 1907, p. 32.

D. The Company Town.

The phenomenon known as the company town also was much more common and significant in the mountain region than on the plains. In such a town, the mining firm owned virtually everything in the community including the houses, retail outlets for food and clothing, and the recreation facilities (see Plate VI). The mine and the company thus effectively controlled most aspects of community life. Again the mining character of the coal towns of the mountain regions was strengthened. One of the recommendations of the 1946 Royal Commission was that legislation be promulgated to abolish the monopolistic nature of the company towns. They continued to persist however.

E. Settlement Patterns.

The importance of the company town, plus the absence of agriculture, were two important reasons why the mountain coal region had virtually no rural or scattered population. Almost the entire population lived in agglomerated settlements centered on mines. This pattern was particularly prominent in the Crowsnest Pass. The geology is such that there are a good many accessible but distinctly separate outcrops of coal deposits (see Fig. 7). These conditions resulted in separate discoveries by many different individuals which in turn gave rise to mines and townsites. At one time the Alberta side of the Pass had ten distinct communities in a distance of less than fourteen miles.[10]

---

[10]W. J. Cousins, A History of the Crow's Nest Pass, unpublished M.A. thesis, University of Alberta, Edmonton, 1952, p. 60.

F. Impermanance of Settlements.

The Crowsnest settlements and nearly all other coal mining centers in the mountain region were essentially one-industry towns. Economic stability is difficult to achieve in a one-industry town under the best of conditions. However, when that one industry depends upon the extraction of a wasting resource the problem is even more acute. W. E. Uren, former Chairman of the Dominion Coal Board, made the following statement in a very realistic article dealing with the coal industry: "Any mine must sooner or later come to an end. That end may be either delayed or hastened by changing costs, new methods of production and other factors but it can not be finally avoided."[11]

When that end occurred for any of the major mines in the mountain regions, the populations which had been almost totally dependent upon it were forced to move away. Communities soon became near ghost towns. According to the census of 1911, Lille in the Crowsnest Pass had a population of over 300. No census since then has noted any population for Lille. Cadomin, which had a population of about 1,500 in 1950, now has less than 100. Similar figures could be cited for other communities in the mountain region such as Brûlé, Mercoal, Mountain Park, Nordegg, and Bankhead.

G. The Social Consequences of Mine Closures.

Miners forced to uproot themselves due to the closing of a mine quite naturally tended to move to other mining communities where they could utilize the only marketable skills they possessed. Hence

---

[11]W. E. Uren, "Canadian Coal in the Years Ahead", Western Miner, vol. 27, no. 11, November 1954, p. 67.

when the C.P.R. closed its mine at Bankhead in 1922, many of the miners migrated to the Crowsnest Pass. The pattern was best exemplified on the Coal Branch. The first major mine to close in the post-war period was that at Mountain Park in 1950. Many of the miners found work in the mines still operating farther north along the Branch. Then Cadomin closed in 1952 and again there was a move north. A similar pattern followed Luscar's closing in 1956. In 1959 the last major mine to operate on the Branch, McLeod River Hard Coal Company of Mercoal, was closed down. The regional economy had totally collapsed (see Figs. 6 & 17).

Ironically when such total collapse of a mining community occurred, there was some consolation for those persons who lived in company towns. Naturally in any settlement about to become a ghost town it was impossible to sell any real estate at a price even approaching its original value.. Hence miners owning their own homes suffered great financial loss. This was the common situation in the Crowsnest. Miners on the Coal Branch and in the Nordegg district, where company towns were the rule, suffered somewhat less.

Nevertheless, whether moving entailed great financial loss or not, the miners had no choice but to leave. In some other regions of the world which also saw major coal mining industries decline rapidly in the post-war period, the problem was less serious. In Pennsylvania, or southern Belgium, or northern France, the closing of many coal mines has thrown thousands of miners out of work. However in these areas, coal mining did not represent the sum total of the economy to the degree that it did in the mountain region of

Alberta. Instead it was often merely one aspect of a large and varied industrial complex which could absorb a significant proportion of the redundant miners.

No such industrial complex existed in the Alberta mountain region; the miners were thus forced to move. This often meant great personal hardship. Unlike the roving adventurers who follow the gold mining industry, coal miners tend to be more sedentary, tend to be family men with a stake in the community. Moving for them was very difficult. Even so the Alberta miners had one slight advantage over the coal miners of Nova Scotia where a similar decline had occurred. There, in contrast to Alberta, more than 80 per cent of the miners are Canadian born. Several generations of men have lived in the same community and worked the same mine. Alberta's immigrant miners generally had less traditional attachment to their communities, and moving was thus somewhat easier psychologically.

Nonetheless, whatever the extent of the psychological ties to the community, moving still meant financial hardships. To alleviate the situation, the provincial government passed the Coal Miners Rehabilitation Act in April, 1954. It provided $150,000 for the improvement of the lot of coal miners thrown out of work. Most of the money was spent in aiding miners to move themselves and their families from depressed mining areas to other parts of Alberta and Canada where better employment opportunities existed. During the first six years after the passing of the act, 695 families were moved under government assistance. The mining districts from which they moved were as follows:[12]

---

[12]Canada, Royal Commission on Coal (1959), Submission by the Department of Mines and Minerals, government of the Province of Alberta, Calgary, March 31, 1960, p. 11.

Coal Branch	294
Nordegg	214
Crowsnest Pass	132
Drumheller	49
Canmore	6

These figures readily attest to the relative importance of the coal industry in the mountain region compared to that of the plains. In the mountains, coal mining was virtually the sole source of employment. When a major mine closed, large numbers of families were forced to move. On the plains, coal never dominated the economy to the same extent. Other sources of employment were able to absorb some redundant miners. Moreover, the marked seasonality of the plains operations meant that coal mining there had never had the same importance as a steady source of employment that it had in the mountain regions.

VII. Seasonality in the Mountain Mines.

Seasonality was not as characteristic of the mountain mines as it was of the plains mines, since the distinctly seasonal household fuel market played a less important role. The bituminous mines thus provided steadier employment. However, fluctuations in production certainly occurred. The following figures in Table XVI refer to the average number of days worked in the bituminous mines of Alberta at various levels of capacity during the early 1920s, a boom period for the coal industry.

Comparing these figures with the corresponding ones for the sub-bituminous mines (see TableXIV , p.201), it may be seen that the record of the bituminous mines is not that much better.

TABLE XVI[13]

PERCENTAGE OF CAPACITY USED IN REPRESENTATIVE MOUNTAIN MINES, 1921, 1923, 1924

Per cent of full capacity	average number of days worked		
	1921	1923	1924
81-100	83	103	56
61-80	66	62	24
41-60	59	35	9
21-40	16	21	9
1-20	9	9	1
Idle	72	75	204
	305	305	303

[13]Alberta, Report of the Alberta Coal Commission, 1925, Edmonton, 1926, p. 77.

TABLE XVII

DISTRIBUTION OF SHIFTS WORKED IN SAMPLE STEAM COAL MINES OF ALBERTA AND SOUTHEASTERN B.C. FOR SELECTED YEARS 1931-1944.

	Percentage of Men Working			
	less than 100 shifts	100-199 shifts	200-299 shifts	300 or more shifts
1931	23	61	13	3
1936	8	56	30	6
1939	11	47	37	5
1942	16	17	53	14
1944	14	13	62	11

Source: Canada, Report of the Royal Commission on Coal, 1946, Ottawa, 1947, p. 305.

In the 1930s and 1940s, however, the bituminous mines definitely did provide steadier employment, as indicated in Table XVII.

This record is considerably better than that of the sub-bituminous mines in the same years (see Table XV , p. 202 above). Thus in 1944, nearly three-quarters of the miners in the bituminous mines worked 200 or more shifts whereas less than half of the sub-bituminous miners did so. The above table also reveals, however, that nearly one quarter of the bituminous miners worked less than 100 shifts in 1931. In the depth of the depression in 1932, it was common for miners in the Crowsnest Pass to work only one shift per week.

VIII. Labor-Management Relations.

Relations between labor and management in Alberta's coal industry have a somewhat checkered history. A very serious strike occurred in 1911. It lasted eight months and ended with the union completely defeated, due to the ready availability and use of non-union labor. Two prolonged strikes occurred in 1922 and 1924. The effect of the 1924 strike is reflected in the figures for the number of days worked in that year as shown in Table XVI . Production in many of the major mines of the province was only one-third to one-half of that of the previous year. From labor's standpoint these strikes were somewhat more successful than most earlier ones had been.

It is hardly surprising that labor relations in the dark days of the depression were less than amicable. Extremism was rampart in some key areas. The radical Workers' Unity League was a significant force from 1931-1936. Several serious strikes during this period were Communist organized, notably in the Crowsnest Pass.

Although strikes did occur in 1945 and 1946, relations since the 1930s have generally been good. This has been due in large part to the efforts of the United Mine Workers of America (U.M.W.A.) which in fact throughout its history in Alberta has been a conservative influence. It is interesting to note that in their respective briefs to the Carroll Royal Commission of 1946, the Maritime district representatives of the U.M.W.A. advocated nationalization of coal mines whereas representatives of District 18 , from western Canada, expressed general satisfaction with industrial relations and recommended that private ownership of the coal mines be retained.

A major factor in the policies of the U.M.W.A. has been the influence of its long-time leader, John L. Lewis. He has been one of the most perceptive and realistic labor leaders of the century. Some unions have favored feather-bedding practices, production limits, and other measures which in the end are meant to impede progress. Such ideas are alien to Lewis' way of thinking. He has always firmly held that job security is possible only in a sound, competitive industry. An industry which rejects technological advances becomes a high cost industry. Its future becomes uncertain and with it the jobs of all of its employees. With modernization, the jobs of some are assured, though admittedly the jobs of others disappear. Yet Lewis has maintained that this situation is to be preferred, that it is better to have one worker employed in a secure and well-paying job than to have two workers employed in positions which pay less well and lack job security. Lewis' views were expressed in a speech in 1948: "The United Mine Workers recognized three or four decades ago that the

only way to increase the standard of living in the mining industry was to create new values by greater productivity. . . ."[14]

IX. Productivity.

Productivity is a key word in any industry, and particularly in the coal mining industry. Again it is of some value to note trends in the United States and elsewhere, comparing them with developments in Alberta. The first year for which the United States Bureau of Mines has productivity figures is 1890, when American coal production was 2.5 tons per man day.[15]

By 1924, American output averaged 4.2 tons per man-day. In 1939 it was 5.3 tons and in 1945 it was 5.7 tons. Advances in the post-war period have been very impressive. By 1958 productivity exceeded eleven tons, nearly double that of 1945, and by 1963, the figure was 15.8 tons per man-shift.

After many years in which relatively little net increase was made in productivity, Alberta's coal industry has shown similar increases in the post-war period (see Figs. 28 & 29).

A. The Pre-war Situation.

The figures indicate only provincial averages however. It is useful to note in more detail the productivity in different mining districts at different times. In 1923 output per man-day in the bituminous region was as follows:

---

[14]"Innovations in Coal Mining", Western Miner, volume 22, no. 2, February 1949, p. 53.

[15]This rate is higher than the average currently attained in any western European country.

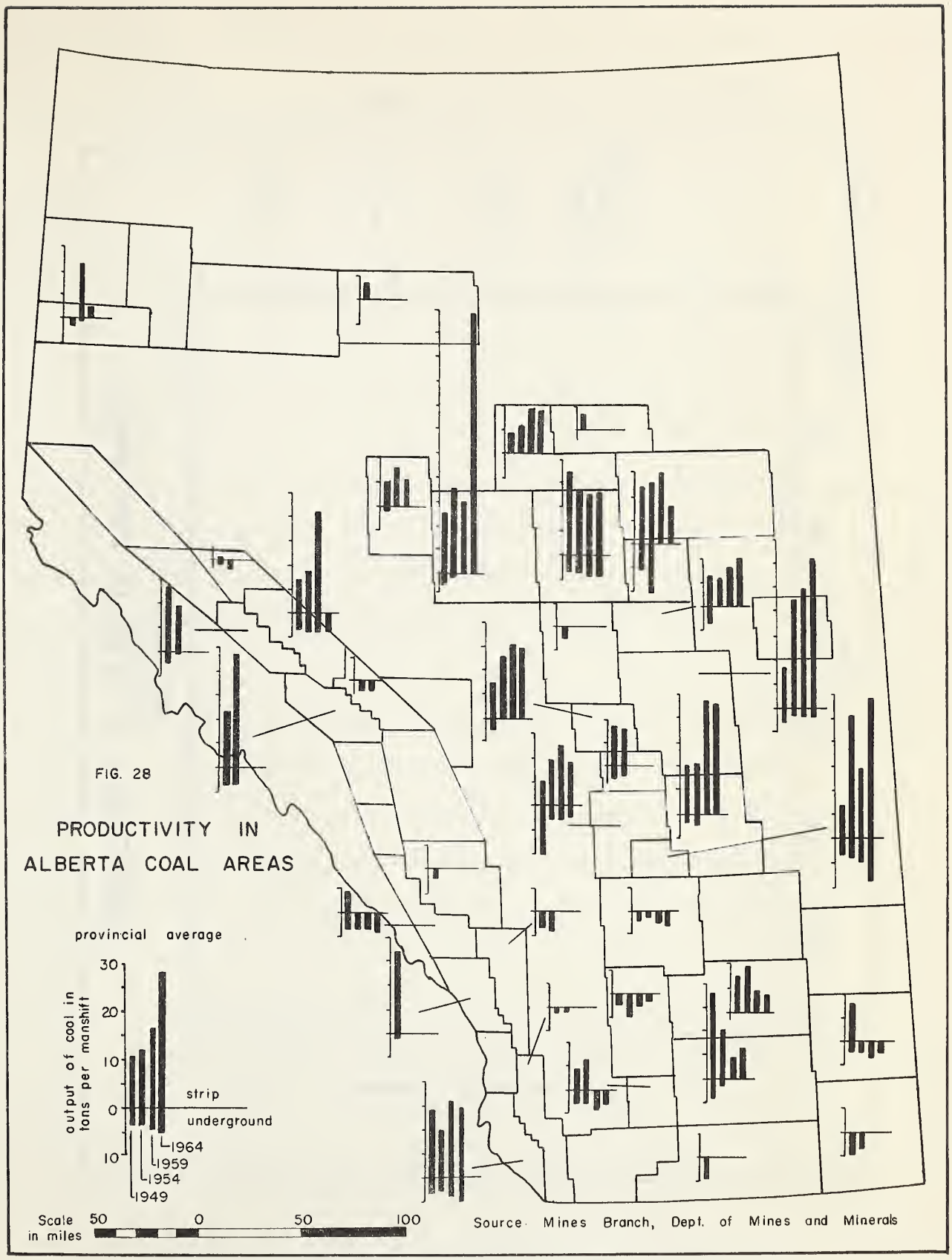
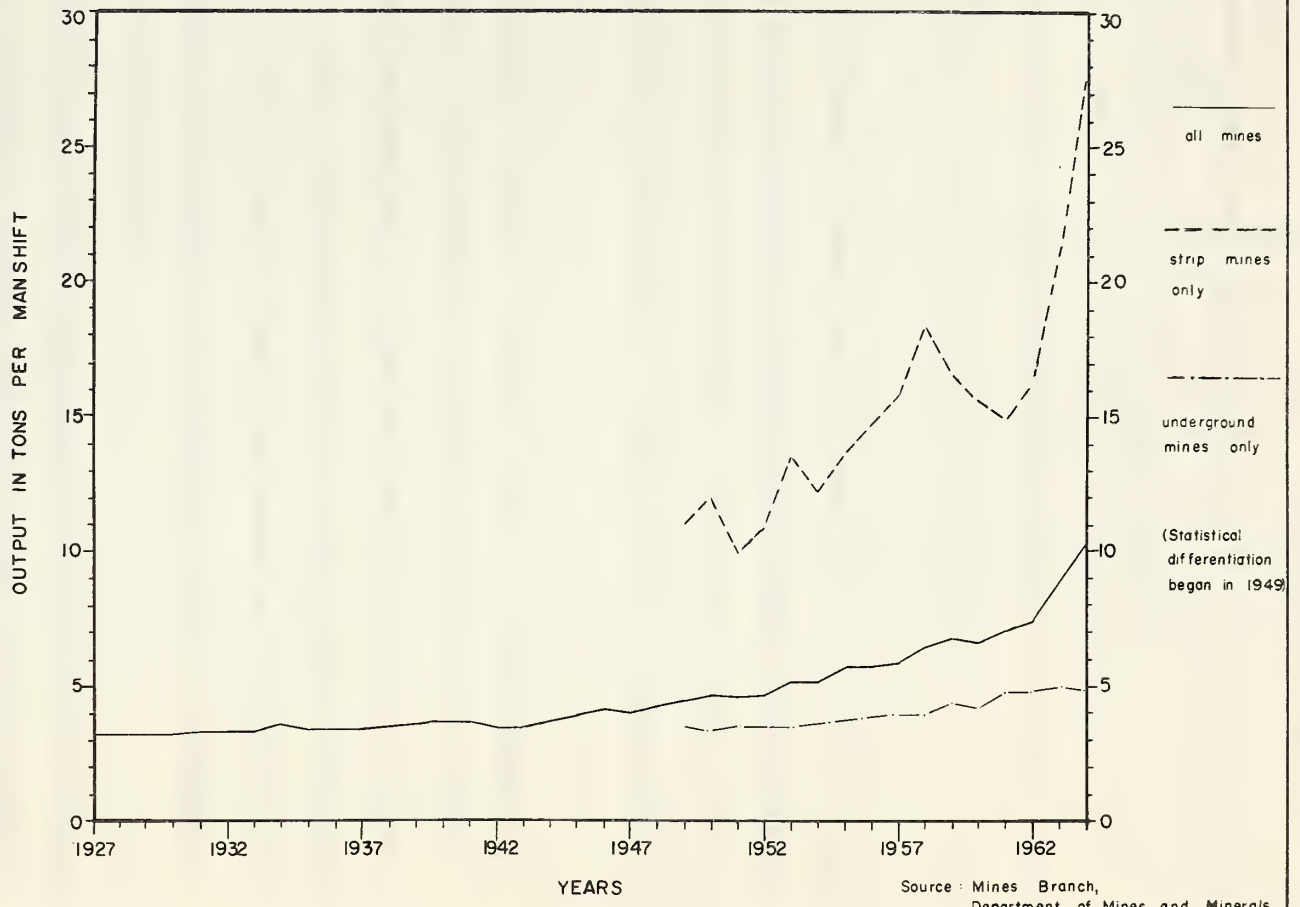


FIG. 28

PRODUCTIVITY IN ALBERTA COAL AREAS

FIG. 29

PRODUCTIVITY IN ALBERTA COAL MINES
1927-1964



Source : Mines Branch, Department of Mines and Minerals

Coal Area	Output in tons per Man-day[16]
Crowsnest	3.3
Mountain Park	3.2
Cascade	3.0
Nordegg	2.9
Brûlé	1.8

Brûlé, with the lowest productivity rating, was a producing area for only five more years after 1923. Crowsnest, which at that time had the highest productivity, is still Alberta's leading bituminous area.

The output from all bituminous mines in 1923 averaged 3.0 tons per man-day. It is significant that even with all the plains mines included, the provincial figure was not significantly higher, being only 3.1 tons. This reflects the fact that large scale strip mining machinery, which has so greatly increased the productivity of Alberta's leading plains mines in the post-war period, was unknown in the province in the 1920s.

Productivity in most Alberta mining areas did not increase significantly throughout the 1930s and early 1940s. Rates attained at the Wabamun Mine of Lakeside Coals were typical of the period.

---

[16]Alberta, Report of the Alberta Coal Commission, 1925, Edmonton, 1926, p. 75

1935..... 4.7 tons per man-day

1939..... 4.1 tons per man-day

1944..... 3.5 tons per man-day[17]

These figures are particularly interesting because the Wabamun Mine was on the site of the present Whitewood Mine of Alberta Coals Ltd. where the use of large scale stripping techniques now makes possible an output of 75 tons per man-shift.

B. World War II and the Growth of Stripping.

Some indications of strip-mining's future were already in evidence by the end of World War II. By 1944 productivity at the two long established stripping operations on the Coal Branch at Sterco and Coal Valley, had risen to 5.5 and 5.3 tons per man day respectively. Though these figures were still much below United States figures, they were considerably above figures for Alberta's underground mines. More important, whereas productivity in Alberta's large bituminous mines scarcely increased at all between the mid-1920s and mid-1940s, productivity at Sterco and Coal Valley almost doubled.

Even more significant were the advances made in strip mining on the plains during World War II. Two major factors were responsible for this growth. The need for increased output by all industries to ensure the maintenance of the military effort had spurred development in many types of mechanization. Many of these improved machines could be adapted to stripping. Secondly the demand for coal itself had provided an impetus for the mining industry. In fact demand for coal was so great that some Alberta strip mines were operated, under special

---

[17]Canada, Report of the Royal Commission on Coal, 1946, Ottawa, 1947, p. 225.

wartime arrangement, by the Emergency Coal Production Board. As a result of the ready machinery and high demand, six Alberta strip mines were producing more than ten tons per man-shift in 1944, as indicated in Table XVIII.

C. Underground Mining in the Post-war Period.

Yet productivity in the underground mines continued to show little improvement. It stood at 3.5 tons per man-day in 1952 and 4.0 tons in 1957, compared with 6.4 tons and 8.5 tons for American underground mines in the same years. Admittedly, however, Alberta's figures were better than those for Canada as a whole. Low productivity in the very high cost Nova Scotia operations brought the Canadian average down to 2.5 and 2.8 tons respectively for the years in question.

In the past five years, however, the average productivity from Alberta's underground mines has improved considerably. There are two reasons for this trend. One is the increased attention being given to improved mining methods. The other is rather a negative aspect. Average productivity has increased greatly due to the fact that scores of inefficient mines have been abandoned in the post-war period. In 1950 there were 108 underground mines operating in Alberta. Even as recently as 1959, the number was still 32. In December, 1965, only four major underground mines were still being worked. Two of these, Amalgamated Coals of East Coulee, and Star-Key Mine on Edmonton's northern outskirts, are on the plains. The others, Coleman Collieries and Canmore Mines, are in the bituminous region.

TABLE XVIII[18]

PRODUCTIVITY IN LEADING ALBERTA STRIP MINES, 1944

Coal Area	Mine	Output per Man-Day
Brooks	Birnwel Coal*	13.5
Taber	Majestic Mines*	12.9
Tofield	Black Nugget Coal	12.7
Taber	Continental Coal*	12.0
Taber	Western Ventures*	10.7
Sheerness	Sheerness Coal	10.6

*Those mines marked with an asterisk were operated by the Emergency Coal Production Board.

[18]Canada, Report of the Royal Commission on Coal, 1946, Ottawa, 1947, p. 110.

Amalgamated Coals is the only major survivor of the more than twenty mines of the Drumheller Coal Area at the end of World War II. The highest productivity in that district in 1944 was 4.3 tons per man-day achieved at both the Regal Coal Company mine and at Murray Collieries. In 1964, output at Amalgamated was 9.9 tons, and during the fall and winter months when the emphasis was on production per se rather than maintenance and other aspects, output exceeded eleven tons per man-shift.[19]

In the two remaining mountain mines, productivity has increased but is still considerably less than that achieved at East Coulee, principally due to the difficulties imposed by the pitching seams. At Coleman Collieries' Vicary Mine, output is about seven tons per man-day.[20] Canmore's productivity is now about 4.5 tons per man-day.[21]

D. Possibilities for Improved Productivity in Underground Mines.

Increased productivity is necessary if Alberta's underground mines are to maintain their markets. This applies particularly to Coleman and Canmore who sell such a high proportion of their output in the highly competitive export market. It is thus useful to attempt to determine the ultimate productivity possible in Alberta's underground mines. Many large mines in the Appalachian region of the United States

---

[19]Pers. comm., A. C. Hnatyshyn, East Coulee, August 5, 1965.

[20]Upton, op. cit.

[21]Pers. comm., W. J. Riva, Canmore, June 23, 1965.

are producing twenty tons per man-day, a rate which is ten times that achieved today in Europe, and more than double that of the highest in Alberta. Moreover, mines now being established in the United States are planned for a rate of thirty tons per man-day.

1. The Plains Region. It is most unlikely that Alberta producers will be able to match these standards, due partly to less favorable geology. In the plains region, the nature of the strata makes the driving of shafts more difficult and more costly than in most of the Appalachian regions. Despite the problem encountered, the entire output of Amalgamated Coals of East Coulee is now machine cut and loaded. Further mechanization would thus consist of replacement of existing plant with more modern equipment. It is felt that this could make possible an ultimate productivity of about fourteen tons per man-day.[22] This would represent an increase of more than 40 per cent over the current rate and an increase of nearly 290 per cent over the rate of productivity in the Drumheller field twenty years ago. Capital is available for such a mechanization program, but market uncertainties do not warrant such outlays at the present time.

2. The Mountain Region. In the bituminous region, pitching seams pose the major problem, partly because most of the machines and techniques which are facilitating the great advances in underground mining in the United States are designed for use in flat seams. Despite the difficulties involved, both of Alberta's major bituminous producers are engaged in extensive mechanization programs. At Canmore, 30 per cent

---

[22]Hnatyshyn, op. cit.

of the output is mechanically mined and 60 per cent is mechanically loaded. Within five years it is expected that 80 per cent will be mechanically mined and the entire output mechanically loaded. Productivity is then expected to reach seven tons per man-day, an increase of 55 per cent over the present level.[23]

At the Vicary Creek mine of Coleman Collieries, a similar mechanization program is under way. When it is completed, continuous miners will be used in all sections of the mine where the pitch is only 12° to 18°. Overall productivity is then expected to be about ten tons per man-day.[24]

X. Size of the Labor Force.

A. The Post-war Decline.

The increasing importance of mechanized mining means that labor as a quantitative factor is becoming relatively less important in Alberta coal mining. Hence although coal production now appears to have passed its nadir, it is highly unlikely that employment in the industry will increase apace with output. Mechanization is merely one factor acting to limit employment in coal mining. At other stages in the industry's development, unfavorable geology and inadequate markets have been responsible for abandonment of major mines and therefore for large reductions of the work force.

Figures 17 and 18 indicate the extent of the reduction of the labor force in Alberta's coal industry. The all-time peak occurred

---

[23]Pers. comm., W. J. Riva, Canmore, June 23, 1965.

[24]Upton, op. cit.

in 1921 with another peak occurring in 1948. From 1948 to 1964 employment fell by 88 per cent.

Some districts suffered very heavily. This was particularly true for the bituminous mining region. Several major producing districts on the plains also suffered serious reductions in their labor forces, (see Table XIX and XX).

It is highly unlikely that the trend revealed in Tables XIX and XX will be reversed. Economists in the United States generally are of the opinion that coal output will increase markedly in that country and will reach 700 million tons annually by the turn of the century. Yet this rise in production will not be accompanied by a parallel rise in employment. On the contrary the latter is expected to decline still further. "Given the vast advances in coal-mining technology since that time [the 1940s] and, one might presume, further progress in the future, it seems likely that coal mining will continue to provide a livelihood for a steadily declining labor force."[25] Precisely the same trends will undoubtedly be observed in Alberta as well.

B. Supply and Demand for Labor

Upon consideration of the substantial decline in the coal industry's labor force in the past twenty years, it would perhaps be natural to assume that a considerable labor surplus now exists, and that several thousand coal miners are unable to find employment. In fact, the precise opposite is true. A marked labor shortage is now a

---

[25]Landsberg, op. cit., p. 291.

TABLE XIX[26]

NUMBER OF PERSONS EMPLOYED IN COAL MINES OF THE MOUNTAIN REGION FOR SELECTED YEARS 1939 - 1963

Coal Area	1939	1944	1958	1963
Cascade	273	311	180	223
Coalspur	294	537	301	10
Crowsnest	1428	2110	335	288
Mountain Park	792	839	13	0
Nordegg	218	439	0	0
Totals	3005	4236	929	521

[26]Canada, Dominion Bureau of Statistics, Annual Reports: The Coal Mining Industry, Ottawa.

TABLE XX[27]

NUMBER OF PERSONS EMPLOYED IN LEADING COAL MINING DISTRICTS OF THE PLAINS REGION FOR SELECTED YEARS 1939 - 1963

Coal Area	1939	1944	1958	1963
Drumheller	1483	1777	698	192
Lethbridge	366	553	132	105
Edmonton	282	309	103	77
Totals	2131	2639	933	374

[27] Loc. cit.

serious problem in several of Alberta's leading mining districts. In contrast, when employment in the industry was at its peak during the 1920s, a labor surplus existed. Such apparent anomalies can be explained through a more detailed look at the historical development of the industry.

1. The Developmental Stage of the Coal Industry. During the developmental stages of coal mining in Alberta in the first quarter of this century, a boom atmosphere typified the industry, particularly in such districts as the Crowsnest. Immigration into Alberta was proceeding at a rapid rate, and the number of men seeking employment was very high. Coal mining was one of the few sources of employment in an almost undeveloped region. It was not an attractive occupation, however. Working conditions were poor, pay very low, job security marginal, and the nascent mining communities rarely offered pleasant community surroundings in which to live. Labor turnover under such circumstances was relatively high. Moreover, labor-management relations were often rather strained, with strikes and lockouts occurring fairly frequently.

2. The Labor Shortage of the 1940s. By the 1940s the situation was considerably different. The coal industry was seriously affected by the siphoning off of manpower for the military services. A distinct labor shortage developed, with skilled face workers being in particularly short supply. The labor shortage persisted after the end of World War II. In 1948, mines in widely separated parts of the province reported that inability to obtain a sufficient number of

skilled miners was definitely restricting their output. The Rosedale Mine of Rosedale Collieries and the Atlas Mine of Century Coals, both in the Drumheller Coal Area, were operating at only 50 per cent of capacity due to the labor shortage. Serious labor shortages were also reported by operators in the Crowsnest, Edmonton, and Lethbridge Coal Areas.

At that time it was widely believed that the greatest problem facing Alberta's coal industry was a shortage of miners.[28] Trade Minister C. D. Howe stated in 1948 that, "Every ton of coal now being produced in Canadian mines is being marketed. The problem is to find more miners rather than mines."[29]

One of the methods proposed as a solution to the problem was that the federal government make a concerted effort to attract immigrant miners.[30] Considerable correspondence was carried on concerning this subject between the associations representing the coal operators on the one hand and the representatives of the provincial and federal governments on the other hand. In the end, however, no effective immigrant labor policy was ever implemented, partly because in the final analysis the coal operators were unable or unwilling to

---

[28]The Edmonton Journal of Nov. 29, 1947, carried an item containing a statement by provincial Mines Branch officials that an additional 1,000 men could be employed in Alberta's coal mines.

[29]Calgary Albertan, June 21, 1948.

[30]Calgary Herald, April 19, 1948.

guarantee year-round employment to immigrants due to the marked seasonality of their operations.

The labor shortage in Alberta's coal industry during and immediately following the war was partly the result of a very significant social change in the mining communities. Until that time, it was automatically assumed that a miner's sons would follow him into the mines. The war disturbed this pattern, and the rapid industrialization and economic diversification which occurred in Alberta during and since the war have further disrupted it. Once young men left the mines and the small mining communities, the line was broken. Returning servicemen often did not take up residence in their former hometowns and if they did, they frequently sought employment in other fields.

3. Loss of Markets and the Effect on Demand for Labor.

The labor picture soon was radically changed, however. With the early 1950s came dieselization of the railroads and the rise of natural gas and fuel oil as household fuels. Whereas there had been a distinct labor shortage in 1948, by 1954 there was a large surplus. Consequently hundreds of miners and their families migrated from districts such as the Crowsnest and the Coal Branch, many going to the large cities in search of employment.

This migration and the reasons for it caused considerable alarm in several quarters. It was recognized that should market conditions improve in the future, the coal industry would have difficulty meeting the demand, for once a force of skilled miners is dispersed, it is extremely difficult to re-assemble them. "It is true

that coal reserves will not deteriorate if left in the ground, but it is equally true that the physical and human resources necessary to make these resources available for use will pass out of the picture unless appropriate steps are taken now to see that this does not occur."[31]

C. Reasons for the Present Labor Shortage.

The phrase "human resources" is a key one. Today the difficulties envisioned in the above submission of the coal operators are being encountered in the Crowsnest. Coleman Collieries weathered the serious decline of the mid-1950s. Production is now more than double that of 1958 and employment has increased by more than 35 per cent to 460 persons. Yet to maintain this new growth, Coleman desperately needs at least thirty more miners. The firm has advertised throughout Alberta and in mining districts of Nova Scotia, but to no avail.

1. Wages. Inability of the operators to obtain labor is not a question of wages. Admittedly in earlier periods, coal miners were paid very poorly. Miners working the Humberstone Mine in Edmonton at the turn of the century were paid $13 per month plus their keep. The situation was not much improved in the 1930s and 1940s. In the year 1931, 86 per cent of those employed in Alberta's sub-bituminous mines earned less than $1,000. Even in the bituminous mines where employment was on a more regular basis, 1941 was the first year in which half of the employees earned $1,500 or more.[32]

---

[31]Canada, Royal Commission on Energy, submission by the Coal Operators' Association of Western Canada and the Western Canada Coal Utilization Council, Regina, April, 1958.

[32]Canada, Report of the Royal Commission on Coal, 1946, Ottawa, 1947, p. 308.

Today the situation is much improved. In 1963 the average earnings of the 627 persons employed in mining in the bituminous fields exceeded $4,400 per person. In the sub-bituminous fields the average earnings were slightly less than $3,500, reflecting the continuing seasonality of these operations.

A sampling of the leading mines in Alberta in 1965 revealed that wages are now among the highest hourly rates in the province. At Amalgamated Coals of East Coulee, largest surviving underground mine of the plains region, miners earn $16 to $18 per day. According to a new contract scheduled to be fully in effect by April, 1966, dragline and shovel operators at the large scale strip operations at Wabamun will be earning nearly $24 daily. And at Coleman Collieries, the province's largest underground mine, contract miners earn $28-$29 per day.

2. Coal Mining's Public Image. The difficulty in recruiting coal miners is thus certainly not due to insufficient remuneration. The problem is one which is less easy to define and less easy to solve. Partly it is a question of improving the public image of coal mining as an occupation. Unfortunately many prejudiced or uninformed people still view it as a job for men who are strong of body, but weak of mind. In actual fact, coal mining today, particularly in the pitching seams of the mountain region, is a very highly skilled occupation. However until coal mining is able to gain an aura of respectability in the eyes of the public, recruitment will remain a difficult problem. Part of the solution may lie in the improvement of the appearance of some of the coal mining communities through urban development programs. Such programs would make living conditions

much more pleasant for the miners themselves and for their families, and would also help to change the image of the coal town in the eyes of the public who often see it as a soot and grime covered company town. The federal government and the British Columbia government are currently studying a plan of this nature which would involve relocation of about 1,200 residents of the grimy coal towns of Natal and Michel in the B.C. section of the Crowsnest Pass. Pending results of this project, Alberta authorities might then have a useful precedent for similar projects in this province.

3. The Difficulties of Attracting Men into Mining.

Basically, then, the reason for recruitment difficulties in the coal industry, is simply that young men do not want to work in the mines, particularly in underground mines. Despite the fact that underground mining today is much safer and, due to mechanization, much less physically arduous than it was even twenty years ago, many young men have no desire to make a career in mining. One understandable facet of this antipathy towards the coal industry is the feeling that its future is uncertain and that it does not provide satisfactory job security.

A final factor which increases the difficulty of recruitment of labor for the coal industry is the existence today of so many other sources of employment. A young man in 1966 who has little desire to go underground can often find employment elsewhere. The young man of the 1920s may also have had no desire to go underground, but he had little choice in the matter. At a time when industrialization and economic diversification in Alberta had scarcely begun, there were

few, if any, other sources of employment. These differing circumstances give some indication how it was possible for the coal industry of the 1920s to have a labor surplus at a time when it was employing over 10,000, while today, with hardly more than 1,000 employed in the industry, there is a distinct labor shortage.

The change in conditions is particularly noticeable in the Crowsnest. Coal production there has been growing steadily since the economic trough of the mid-1950s, and the region's economic health is much improved. However, coal's revival alone is not responsible for the improved position. A gas purification and sulfur recovery plant was established in 1960. Forestry and sawmilling have grown rapidly in recent years. A wire cable plant presently under construction just west of Coleman will soon provide employment for 75-80 persons. Such economic diversification is, of course, very beneficial for the stability of the communities of the Crowsnest. It also helps to explain, however, why Coleman Collieries is currently having such difficulty in obtaining needed labor. The competition for the latter is intense.

4. Age of Miners. The labor shortage in Alberta's underground mines is seen to be even more serious when the age factor is considered. The relatively advanced average age of these skilled employees has been cause for concern for many years. In the early days of the industry, young men made up the bulk of the labor force. However cutbacks in output during the depression of the 1930s led to the layoff of junior employees. World War II led to a further exodus of young men from Alberta's mining communities. The result was a

marked change in the structure of the labor force. In 1921, 55 per cent of the miners were less than thirty-five years old. By 1941, only 26 per cent of the labor force was in this category.[33] And by 1947 the average age of Alberta's underground miners was fifty-six years.[34] Today the problem remains acute. Until now Amalgamated Coals has had little difficulty in recruiting 35-45 extra men for its winter operations. However, the rising average age of the miners could create a manpower shortage in the near future. Similar difficulties are being anticipated by Coleman Collieries.

5. Mechanization: A Partial Solution. Mechanization, in one form or another, is expected to be a major factor in easing the labor shortage. The emphasis on stripping has several advantages. Many young men unwilling to go underground will readily accept employment in surface operations. Moreover, though stripping requires skilled machine operators, the skills involved are seldom as exclusive or as difficult to master, as those associated with the underground mining of pitching seams. The high productivity achieved in stripping means that the overall labor needs are much reduced.

Mechanization will also be the main method used by the underground mines in an attempt to meet their labor shortages. The use of continuous miners in the Vicary Mine will substantially reduce labor demands and it will likely be unnecessary for Coleman Collieries to replace retiring miners for some years.

---

[33]Canada, Report of the Royal Commission on Coa, 1946, Ottawa, 1947, p. 141.

[34]F. H. Stephens, "The Foothills Province", Western Miner, vol. 21, no. 8, August 1948, p. 57.

XI. The Move Towards a Capital Intensive Industry.

The increasing significance of mechanization has many ramifications for Alberta's coal industry. Until the end of World War II, the latter was very definitely a labor intensive industry. This was particularly true in the large bituminous mines of the mountain region, including those in the Crowsnest, Cascade, Brazeau, and Mountain Park Coal Areas. Here labor accounted for 55-60 per cent of total costs in the period 1930-1944.[35]

Today the situation is greatly changed. Increasing outlay on mechanized equipment has made possible higher rates of productivity. Quantitatively, therefore, labor is becoming less important in Alberta's coal industry. Instead the latter is becoming increasingly capital intensive, as are its competitors, the oil and gas industries. No longer will the marketable products of the coal industry be exclusively ones of high bulk and low value. Rather it will come to depend more on sales of smaller bulk but higher value, of processed coal in the form of active carbons, structural carbons, and fertilizers. The only major remaining bulk markets will be in the domestic thermal power industry and the Japanese metallurgical industries. Even here, with an emphasis on large machines such as the Wabamun dragline, the increased demand ". . . will have little bearing on the conventional [underground] coal-mining industry."[36]

---

[35]Canada, Report of the Royal Commission on Coal, 1946, Ottawa, 1947, p. 189.

[36]Alberta, Annual Report: Alberta Power Commission, Edmonton, 1963, p. 30.

XII. Coal's Present Status as a Stimulus for Regional Development.

With labor assuming a less important position in the production of coal, the need for accommodation and other facilities for miners at the mine site will be correspondingly less. This, plus the existence of much better systems of transport and communication than Alberta had fifty years ago, means that coal will no longer give rise to characteristic coal towns based on intensive labor input.

This is not to say that coal has not continued to play an important role in opening up new areas of Alberta in the post-war period. Nor is it to say that the existence of coal will not be a stimulus to the economic development of more such areas in the future. In the mid and late 1940s the search for new coal deposits led survey parties of the R.C.A. into widely scattered areas of Alberta including the Wapiti River area of the Peace River Block, and the Ribbon Creek area south of Canmore.

A. The Smoky River Deposits.

The coal deposits which are most likely to stimulate economic activity in a relatively undeveloped section of Alberta are those which lie in the Sheep Creek-Smoky River district about eighty miles north-northwest of Jasper (see Fig. 10). Existence of the reserves has been known for over fifty years. The first prospecting was done by men associated with the Canadian Northern Railway. A G.S.C. party led by John MacVicar carried out studies on the coal reserves of the region in 1911 and 1916.

Estimates of the size of the reserves of the Smoky River coalfield vary widely, ranging from 500 million tons[37] to MacVicar's 9,700 million tons.[38] Much of the variation is due to a lack of agreement on the limits of the coalfield. Sheep Creek is generally considered to mark its northern edge. It extends southwards at least as far as the mouth of the Sulphur River, a distance of about fifteen miles. MacVicar also included within his estimates the deposits along the Wildhay River and even the Moosehorn Creek deposits seventy miles southeast of the mouth of the Sulphur River.

Although opinions differ as to the overall size of the field and its reserves, it is agreed that the major deposits are those of the Gustav Flats area on the Smoky River about five miles upstream from the mouth of the Muskeg River. The coal at this point is low volatile bituminous, suitable for coking.

Development of these reserves has been discussed for decades. Surveys were carried out by the Canadian Northern Railway for a branch line up Solomon Creek and the Wildhay River to tap the deposits. MacVicar was also very confident that the Smoky River Coalfield would be worked on a large scale.

Utilization of the deposits has not come about for several reasons. Mining would involve similar difficulties to those encountered at Canmore and Coleman, where geological conditions are much the same.

---

[37] The Edmonton Journal, May 8, 1964.

[38] John MacVicar, "Preliminary Investigations of Coal Deposits on Smoky, Hay, and Berland Rivers, Alberta", Summ. Report, G.S.C., 1923, Part B, p. 22.

Folding and faulting has been severe, resulting in steeply pitching seams and highly friable coal.

Lack of adequate markets has been the main deterrent to development. However beginning in 1962 representatives of U.S. Steel of the United States and Mitsubishi of Japan have carried on tests on the Smoky River coals. Japanese interest appears to have been the key factor in the decision of the Alberta government to finance construction of a railroad to render the coal deposits accessible. The decision was announced in January, 1965. The Alberta Resources Railway will begin at Solomon, a C.N.R. mainline station 11.5 miles west of Hinton, and run for approximately 100 miles northwest (see Fig. 10). Location surveys for the line were completed in November, 1965, and clearing of the right-of-way began in the winter of 1965-66. The railway will facilitate movement of Smoky River coal to tidewater at Prince Rupert prior to shipment to Japan.

Ultimately it is expected that the Alberta Resources Railway will be extended another 100 miles northwards to link up with the Northern Alberta Railway at Grande Prairie, thus establishing a direct connection with the recently completed Great Slave Lake Railway. This new through route would provide a considerable stimulus for various types of economic activity in northwestern Alberta. Three pulp mills are expected to locate in this area within the next three years. Agricultural produce from the Peace River Block and from newly developed land adjacent to the Great Slave Lake Railway could be readily transported to market via the new rail link. Other minerals

besides coal would utilize the route. These would certainly include the base metals from the Pine Point district, and possibly iron ore from the Clear Hills and gypsum from the northwest corner of Alberta. The immediate stimulus for all this increased economic activity is the Smoky River Coalfield.

B. The Improbability of New Coal Towns.

Thus coal continues to be an important factor in the opening up of relatively undeveloped sections of Alberta, just as it was half a century ago. Yet it is highly unlikely that development of the Smoky River Coalfield will spawn settlements which are such creatures of the coal industry as were, for example, the towns of the Coal Branch. Certainly the coal industry would be of major significance, but it would not be an overwhelming influence to the exclusion of all others. The reduced relative importance of labor would be one reason. Other industries, notably tourism and forestry, would contribute to the regional economy. Moreover it is unimaginable that a burgeoning district born today could persist for more than thirty years with no year-round access by automobile as was the case for communities in the Mountain Park and Brazeau Coal Areas which still lacked all-weather road connections with the rest of Alberta in the late 1940s. This isolation factor was of considerable importance in contributing to the shaping of the character of the coal towns.

The labor factor has been a key one in Alberta's coal industry since the latter's inception. Seasonality of operations and fluctuations in output caused by changing market conditions have meant hardships for those employed in the industry. Today Alberta's coal mining labor force numbers little more than one thousand, and

with the increasing emphasis on mechanization, labor's relative position is becoming less important. However with Alberta operators seeking to sell in international markets, it is essential that the productivity of this labor force be continually improved. Thus, though it may be small quantitatively, its importance in a qualitative sense is greater than ever before.

CHAPTER VIII

CHANGING ATTITUDES TOWARDS THE ALBERTA COAL INDUSTRY

I. Misconceptions Regarding the Coal Industry.

There are a number of widely held misconceptions concerning certain aspects of coal and the coal industry of Alberta. These misconceptions appear in the ideas voiced by some of the consumer public, some of the coal producers, and by some of the people responsible for the formulation of economic policy affecting the coal industry.

A. Obsolescence.

Many Canadian consumers regard coal as an obsolete fuel, one that is dirty and inconvenient, despite the recent advances made in the development of automatic coal stokers. The improvement of coal's public image might be accomplished through a concerted advertising campaign akin to the highly successful ones carried on by the coal producers' competitors in the oil and gas industries. The ignorance of the public is such that the production of electricity from coal-fired power stations is regarded by many as being outmoded.

B The Effect of Stripping on the Landscape.

The image of the coal industry also suffers because many regard it as a dirty industry, one which leaves permanent unsightly scars on the landscape. Strip mining is seen as a particularly serious offender. Admittedly the mined over landscapes near Grassy Lake, Halkirk, and parts of the Coal Branch, including Robb and Mountain Park, are certainly most unattractive (see Plate VII). In extreme

PLATE VII

INFLUENCE OF STRIP MINING ON THE LANDSCAPE

A. Forestburg Collieries

B. Strip-mined area.

C. Battle River Station of Canadian Utilities Ltd.

D. Dam on Battle River to ensure water supply for cooling purposes

E. Battle River Coal Co. Ltd.

Battle River Strip Mining Operations
Scale: 1" = 4,450 feet.

Ridge and Valley Topography.

Strip-mined area, Battle River Coal Co. Ltd.

cases the scene is one of complete desolation. Hillocks of waste material and ridges of overburden stripped to uncover the coal seams are features of such a landscape. Drainage is deranged, topsoil often destroyed, and vegetative patterns disrupted.

The problems which can develop as a result of uncontrolled mining practices have long been recognized. The first legislation on this continent designed to provide for the reclamation of stripped land was passed in 1939 by the legislature of West Virginia, now the leading coal producing state in the United States. Similar legislation came into effect in Alberta in 1952. It is not as stringent as some corresponding legislation in the United States. In parts of Pennsylvania, for example, mining companies are required to strip off the topsoil first, store it separately, and replace it when mining has been completed. A restoration of the original contours of the surface is also stipulated, as is revegetation of the area.

In contrast, Alberta legislation specifically requires only the back-filling of strip pits, with no stipulations regarding replacement of topsoil or revegetation of the surface. However in practice the surface is generally revegetated in some manner, lest the mining firms run afoul of the Department of Agriculture's weed control program. Commonly the spoil is replaced, the surface is graded somewhat, and then seeded to brome grass or clover. Some of the stripped and restored land of Forestburg Collieries is leased for the grazing of cattle. Other uses to which reclaimed land has been put in the United States include fruit farming, forestry, grain crops, and recreation.

One of the misconceptions held by some Alberta strip coal operators is that reclamation is totally unnecessary and merely adds to costs. In fact, proper backfilling can be done for 5¢ per ton of coal produced. Moreover, more elaborate reclamation procedures often become positive assets, bringing the firm added profits rather than being a costly chore. Good cash crops are now being taken off stripped and reclaimed land near Alix (Sissons Mine) and Egg Lake (Egg Lake Coal Company) (see Fig. 4). Other mines which are doing a creditable job of restoring stripped land to a state approaching its original condition include the large scale operations at Wabamun, Sheerness, and Taber.

C. Population, Industrial Location, and Coal Production.

1. The Relationship Between Population Density and Coal Production. Several writers have drawn comparisons of dubious value between Alberta's population and her coal output. Stephen B. Jones noted that there was a great discrepancy between Alberta's share of the world's population and her share of coal output.[1] Similar comparisons were often made by Dowling in his G.S.C. reports of 1905-1915. He implied that there is a natural correlation between coal output and population, and that growth rates of the two should show general similarities. There was some justification for such thinking fifty years ago when coal was so important as a domestic fuel. However, even then many of coal's major markets lay in industry. Heavy industry is less related to quantity of population than to "quality" of population,

---

[1]Jones, op. cit., p. 372.

particularly with respect to its technological level. Coal output depends less on regional population than on regional technology, interfuel competition, and the type of economic system which is dominant.

F. W. Gray, writing in the early 1950s, tried to establish a connection between Alberta's coal output and the regional population density.[2] He contended that a considerable increase in Alberta coal production could only occur if there were a significant increase in population in the Fertile Belt of Alberta and Saskatchewan, roughly between Edmonton and Saskatoon. Such a generalization had only limited validity at the time of its writing, and has even less today. With coal no longer the dominant domestic fuel, its ties with the regional population are insignificant. Alberta bituminous producers now sell in international markets and it is entirely possible that within a few years a large proportion of the sub-bituminous output will go to chemical products and other processed goods which will also depend to a large extent on export sales.

2. The Importance of Raw Materials in Industrial Location. Gray is representative of what might be termed the "coal romantics". The latter have included individuals in politics, labor, and management whose general theme has been that Alberta's vast coal resources should have given rise to a great industrial complex, and that since such

---

[2] F. W. Gray, "Canada and Coal", Western Miner, vol. 24, no. 2, February 1951, pp. 44-46.

development has not yet occurred, definite steps should be taken to see that it does. Gray asks whether ". . . it would not work to our best national interest to promote the deliberate creation of industry upon the Western Coalfields?"[3]

Such a development would be contrary to present trends in industrial location. In the United Kingdom it is true that major industrial regions such as the Midlands and Tyneside have arisen on coalfields. However the early growth of British industrial regions occurred before the railroad era and long before the age of the internal combustion engine. Large-scale movements of bulk goods, such as fuels and other raw materials, were thus very difficult and very expensive. Industries were necessarily tied quite closely to primary resources.

The mere existence of raw materials, however, is not to be equated with economic wealth. Most of the fuels and metallic minerals are millions of years old, yet they have been of economic significance for less than 5,000 years, many of them less than fifty years. The economic value of a naturally occurring material thus depends upon man's ability and desire to utilize it. Since man's needs, tastes, and capabilities vary through time, so does the relative value of raw materials vary.

Hence, though raw materials were commonly the dominant factors of industrial location in 1800, this is much less true today. New York, Montreal, Hamburg, and Rotterdam are all great industrial centers, yet none are on coalfields or directly adjacent to any other raw materials

---

[3] Ibid., p. 45.

of major significance. Today other factors such as market, labor, and transport and communication facilities are assuming positions of much greater importance. Whereas a century ago only the most valuable goods, those of high value and low bulk, could stand transport costs, manufacturers today often find it economically advantageous to transport the low value, high bulk commodities to market centers, process them and distribute a good proportion of the high value finished products within the immediate area.

Thus the relative importance of raw materials as factors of industrial location has declined considerably in the past century. This is particularly true of energy resources. Gray wrote that ". . . unless Canada is to prove the one exception to a world-accepted rule, [the energy resources of the western provinces] will draw population to buy the cheaply provided goods that a generous local supply of energy will make possible."[4]

The use here of the phrase "world-accepted rule" is scarcely justified now. Few of the world's major population centers are based on large local energy supplies. London and New York are two obvious examples of great industrial cities with extremely small local energy resources. In fact of all the cities in the United States with populations exceeding one million, in only one case, that of Pittsburgh, has occurrence of energy resources been a clearly dominant factor in the city's growth.

---

[4] F. W. Gray, "Canada and Coal", Western Miner, Vol. 24, no. 2, February 1951, p. 45.

In his study done in connection with the 1957 Royal Commission on Canada's Economic Prospects, John Davis closely investigated the importance of energy to industrial location. His findings revealed that expenditures on energy as a cost item in Canadian manufacturing have been falling, relative to other cost items, since 1935. Thus ". . . the drawing power of sources of cheap energy on manufacturing in general has been weakening [and] energy costs have become a less important factor in respect to the locating of the great majority of industrial establishments."[5]

The "coal romantics" remain undeterred in the face of such findings. Too many Canadians still view natural resources as immediate sources of wealth, regardless of transport facilities, markets, and other key factors. Gray contended that the problems associated with Alberta's coal industry were basically problems of Canadian land settlement. He advocated formulation of policy which would encourage population of the coalfields. "If our population of tomorrow could be placed where it could live off the land and its mineral content, it would lead to a more independent solid and enduring economy than would result from continued concentration of industrialism in southern Ontario, where dependence upon imported coal is so complete."[6]

II. Nationalism and Sentimentality.

A. The Desire to Reduce Coal Imports.

Here the basic thinking behind Gray's ideas shines through. In the final analysis he is arguing as a politician, as a Canadian

---

[5]Davis, op. cit., pp. 37-40.

[6]F. W. Gray, "Canada and Coal", Western Miner, vol. 24, no. 2, February, 1951, p. 45.

nationalist, rather than as one viewing the Alberta coal industry objectively. His ideas are typical of many Canadians who oppose the importation of millions of tons of coal into Canada from the United States every year, while at the same time literally hundreds of coal mines in Alberta have closed in the post-war period due mainly to a loss of markets (see Figs. 13 & 21). The following statement appeared in the submission of the Western Canada Fuel Association to the Royal Commission on Dominion-Provincial Relations: "It does not appear reasonable, economical, or patriotic to import upwards of 15,000,000 tons [of coal] each year from the United States. . . ."[7] On the contrary when one considers (a) that productivity rates in the United States are two to five times greater than those in Alberta, and (b) that the mines of Alberta are 1600 to 1800 miles further distant from Ontario markets than are the mines of West Virginia and Pennsylvania (see Fig. 12), then such large-scale importation of American coal appears to be eminently "reasonable" and wholly "economical". Whether it is also patriotic is more difficult to answer.

The aim of Gray and the other coal romantics is a more self-sufficient Canadian economy. Gray went even further, calling for the creation of more self-sufficient economic regions within Canada. He wrote, ". . . Is it not proper to suggest that the coming industrialization of the West will disclose the illogicality of subsidizing the transportation of Western-mined coal to the industrial East to make goods for consumption in the West, and the unwisdom of paying carriage

---

[7]Canada, Royal Commission on Dominion-Provincial Relations, submission of Western Canada Fuel Association, Ottawa, 1938, p. 1.

costs two ways?"[8] Again a large scale industrialization of the West is assumed to be imminent. However, even if for the moment this point is granted, the statement is still unjustified. It is implied that industrialism should be equated with self-sufficiency. Nothing could be more false.

Industrialism represents one of the most advanced stages of the society of economic man. Such a society is dependent upon specialization of labor. One of the greatest trade volumes in the world is that between the United States and Western Europe, both highly industrialized. Ruhr firms import coal from West Virginia and manufacture machinery which they might well sell to the coal mining company in West Virginia. No one contends that the two way carriage costs are a sign of economic and political immaturity of the two states. Why should Ruhr firms use coal from local mines where productivity is 5 per cent of that of the West Virginia mine? Or why should the West Virginia company not buy Ruhr mining machinery if it is less costly than that made in Pittsburgh?

The view of the coal romantics is thus basically political and nationalistic. Gray wrote that he wished to see a more "unified thinking in Canada" and "a truly Canadian viewpoint" in the utilization of our natural resources. Such ideas are outmoded. In an era when national self-sufficiency is becoming ever more irrational and expensive, if not completely impossible, some Canadians would have us revert to policies resembling those of the economic nationalists of the 1930s.

---

[8] F. W. Gray, "Canada and Coal", Western Miner, vol. 24, no. 2, February 1951, p. 46.

The nationalists often refer to examples from World War II to strengthen their argument. In the 1941-42 fiscal year, about 1,263,000 tons of coal from Alberta and the southeastern corner of British Columbia were shipped to Ontario. Present shipments are less than 0.5 per cent of this wartime figure. It is argued that what was possible in war-time is also possible now. However the war-time shipments east were necessary because the United States needed its own coal to meet the war effort and was unable to maintain its exports. The fact that Alberta shipments eastwards after 1945 dropped sharply indicates that war-time arrangements were uneconomic. Many things done in war-time cannot be done on a sustained basis in peacetime. Germany, for example, was virtually self-sufficient in oil at times in World War II, yet no Germans contend that a similar policy should be followed today.

B. Nostalgic Thinking in the Formulation of Coal Policy.

Too often, opinions expressed on Alberta's coal industry are colored by overly sentimental memories of coal's place in the province's history. Speaking in the House of Commons in June, 1950, Trade Minister C. D. Howe said that, "I would do anything at this time but encourage the Western coal industry in the belief that it has a bright future." Such a frank realistic statement on the part of a politician is highly commendable, yet it was greeted with comments such as the following in a mining journal. "The attitude reflected [in Howe's statement] could . . . mean the collapse of an industry that has done more for the West than almost any other single factor."[9] Admittedly

---

[9] C. Pattinson, "Freight Rates and the Coal Mining Industry", Western Miner, vol. 24, no. 3, March 1951, p. 43.

coal has been of great historic importance in the development of the West, but the influence of wheat, livestock, and the railroads must also be considered. The excessive degree of sentimentality which is associated with Alberta's coal industry must be reduced if Albertans and Canadians in general are to be able to examine and evaluate the coal industry more objectively. In this regard one valuable body of material is that which has been produced by the several Royal Commissions on coal. The commissions have provided a valuable service in gathering information on the industry from a wide variety of sources. Their recommendations have generally been realistic. However insofar as their purpose was to solve the problems of the industry, they failed. This is to be expected. The major problems faced by Alberta coal operators relate to geographic factors which cannot be overcome in a short time. These include difficult mining conditions in the mountains, inadequate regional markets, and an absence of economic means to reach more distant markets.

III. Conclusions.

Yet it is quite probable that Alberta's coal industry will assume a position of increased importance in the future. However the industry will also be greatly changed in form from the one looked back to with nostalgia by the coal romantics. The pick and shovel have been and are being supplanted in the bituminous mines by duckbill conveyors and continuous miners. The major strip mines of the plains utilize large electric shovels, draglines, and early in 1966, it was revealed that studies are being carried out to determine the feasibility of using bucket wheel excavators for stripping operations in Alberta coalfields, including Ardley.

Markets, too, have changed. The mountain mines, formerly dependent almost entirely on the railroads' steam locomotives for their sales, now rely mainly on the Japanese steel industry, with the metallurgical industries of Trail and Flin Flon also of considerable importance. In the future it is possible that the steel industry of the United States may come to rely to an increasing extent on Alberta coking coal.

The markets of the plains mines are also very different now from those of the prewar period. The household fuel market, formerly dominant, has largely disappeared. Instead, thermal power generating stations comprise the major markets for the sub-bituminous mines. It is likely that the carbochemical industry will provide an increasingly larger market in the future. Coal-based fertilizers are expected to be of particular importance.

Changes are also apparent in the transport of coal. Output from the mountain mines is still shipped almost entirely by train, but new concepts in rail traffic involving use of unit and integral trains are being studied. For the plains mines, shipment by truck is gaining in importance. For those mining operations oriented to thermal power generation at stations located on coalfields, the coal is trucked from the strip pits to the generating station, with the final product, electricity, being transported by power lines to the load centers. There appears to be a good possibility that pipelines will be an important means of transporting Alberta coal in the future. They could be used in shipment of bituminous coal to tidewater on the pacific Coast, or in movement of sub-bituminous coal to thermal generating stations in eastern North America.

Important changes are also occurring in the relationship between the coal industry and the population dependent upon it. It is unlikely that coal will ever again give rise to the characteristic coal towns such as those which developed in the Coal Branch between 1910 and 1930. The coal industry today is increasingly capital intensive. The old coal towns which were based upon large scale expenditures of manual labor fortunately are now an historical feature. An increasingly large proportion of those in the coal industry will be involved in secondary processing and marketing, particularly as the carbochemical markets and international markets grow in importance.

Meanwhile great changes have occurred in Alberta as a whole. Durings its development stages, the coal industry was of much greater relative importance to the province than it is now.[10] Today Alberta's economy is far more diversified than it was fifty years ago. New industries, particularly those associated with oil and natural gas, are of major significance.

The coal industry has come through a difficult transition period since 1950, and is still greatly overshadowed by some of Alberta's newer industries. Yet it continues to be of considerable importance. The value of coal produced in 1964 was $11,200,000. Even more significant is the fact that this represented an increase of 13 per cent over the value of the 1963 coal output. This is only the second time since 1949 that the value of Alberta coal production has exceeded that of the previous year.[11]

---

[10]The value of coal production comprised more than 80 per cent of the value of Alberta's entire mineral industry, in 1935. The figure is now less than 5 per cent with oil and natural gas being of major importance.

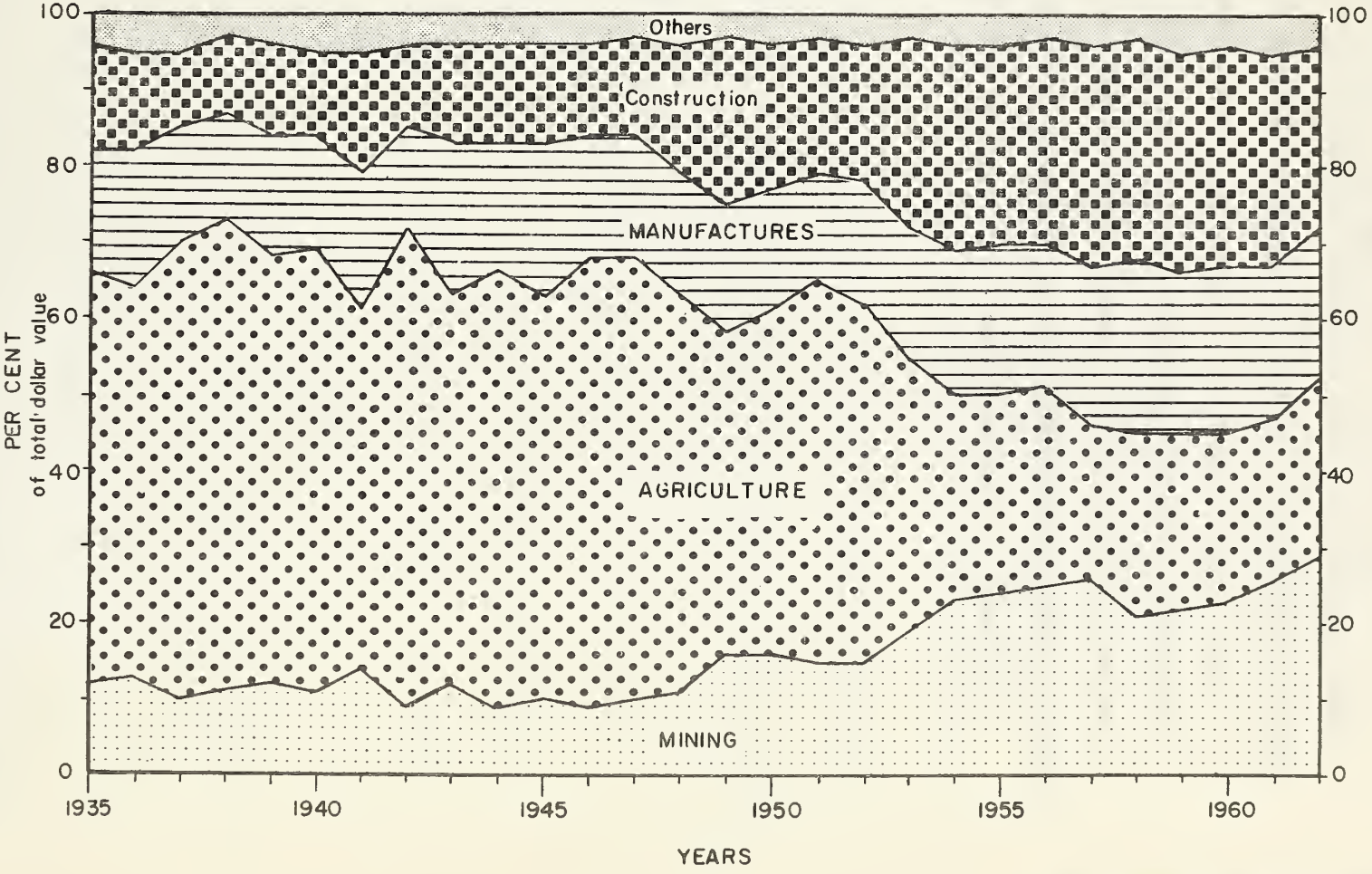
[11]The value of production in 1959 exceeded that of 1958 by 1 per cent.

FIG. 30

MINERAL PRODUCTION IN ALBERTA'S ECONOMY

1935-1962

MINING AND OTHER LEADING INDUSTRIES AS A PERCENTAGE OF ALBERTA'S TOTAL ECONOMIC OUTPUT



Source : Dominion Bureou of Stotistics, Survey of Production, June, 1965

The industry thus appears to have been successful in carrying out very considerable changes in the past fifteen years, both in its own methods of production and in its marketing patterns. Labor requirements have been greatly altered and they in turn have brought about changes in the settlements and types of settlements in the production areas. Thus changed in these important aspects, the coal industry will continue to be an important factor in Alberta's geographic patterns of industry, transportation, and population distribution.

BIBLIOGRAPHY

Abousaffy, N. F., pers. comm., Coleman, August 6, 1965.

"Activity on the Coal Branch", Western Miner, Vol. 22, No. 10, October, 1949, p. 158.

Alberta, Annual Reports: Alberta Power Commission, Edmonton, 1951-1964.

_____, Report of the Alberta Coal Commission, 1925, King's Printer, Edmonton, 1926, 391 pp.

_____, Report of the Royal Commission Respecting the Coal Industry of Alberta, 1935, King's Printer, 1936, 103 pp.

_____, Royal Commission on the Development of Northern Alberta, Edmonton, 1958, 115 pp.

_____, Dept. of Economic Affairs, Alberta's Economic Prospects, Edmonton, 1955, 366 pp.

_____, Dept. of Industry and Development, Bureau of Statistics, Alberta: Industry and Resources, 1964, Edmonton, 1964, 187 pp.

_____, Dept. of Mines and Minerals, Annual Reports: The Mines Branch, Edmonton, 1905-1964.

"Alberta Coal Issue", The Mannix Story, Vol. 10, No. 5, November, 1962, Mannix, Calgary, 24 pp.

_____, The Mannix Story, Vol. 11, No. 5, October, 1963, Mannix, Calgary, 24 pp.

"Alberta Coal for Ontario", Western Miner, Vol. 23, No. 2, February, 1950, p. 68.

"Alberta's Leading Coke Plant", Western Miner, Vol. 21, No. 8, August, 1948, pp. 90-91.

Alberts, L. W., et al., "Production of Methane from Coal", Chemical Engineering Progress, Vol. 48, No. 10, October, 1952, pp. 486-493.

Allan, James, accountant for Lethbridge Collieries Ltd., pers. comm., Lethbridge, August 6, 1965.

Allan, John A. Coal Areas of Alberta, Research Council of Alberta, Report No. 34, Edmonton, 1943, Part V, pp. 161-196.

_____, Geology and Coal Occurrences of Wapiti-Cutbank Area, Alberta, Research Council of Alberta, Report No. 48, Edmonton, 1946, 43 pp.

_____, Geology of Drumheller Coal Field, Alberta, Scientific and Industrial Research Council of Alberta, Report No. 4, Edmonton, 1922, 72 pp.

_____ and J. L. Carr, Geology of Highwood-Elbow Area, Alberta, Research Council of Alberta, Report No. 49, Edmonton, 1947, 74 pp.

_____ and Ralph L. Rutherford, Saunders Creek and Nordegg Coal Basins, Alberta, Canada, Research Council of Alberta, Report No. 6, Edmonton, 1923, 66 pp.

_____ and J. O. G. Sanderson, Geology of Red Deer and Rosebud Sheets, Alberta, Research Council of Alberta, Report No. 13, 109 pp.

American Coal Sales Association, Handbook for Coal Salesmen, Washington, 1951, 195 pp.

Armstrong, D. E., and R. E. McClary, Analysis of Power Costs in the Province of Alberta, Research Council of Alberta, Mimeographed Circular No. 13, Edmonton, 1952, 76 pp.

Baltzer, C. E., "The Canadian Power Situation With Particular Reference to Thermal-Electric Power", T.C.I.M.M., Vol. 61, 1958, pp. 32-39.

_____, "Comparative Costs of Handling Coal and Residual Oil," Proc., Fifteenth Dominion-Provincial Conference on Coal, Halifax, September 19-20, 1963, pp. 76-90.

Bateman, Alan M., "Geographical Factors in the Utilization of Mineral Deposits", pp. 437-447 in Outside Readings in Geography, ed. by F. E. Dohrs, L. M. Sommers, and D. R. Petterson, Thomas Y. Crowell, New York, 1955.

"Battle River Strip Mine", Western Miner, Vol. 22, No. 4, April, 1949, p. 162.

Beach, Hugh Hamilton, The Geology of the Coal Seams of Edmonton and District and a History of Their Mining Development, unpublished M.Sc. thesis, University of Alberta, Edmonton, 1934, 148 pp.

Berkowitz, Norbert, Head, Coal Research Division, Research Council of Alberta, pers. comm., Edmonton, November 19, 1963, and May 17, 1965.

_____, "Coal as a Non-Fuel Source Material: The Present Status", The Engineering Journal, Vol. 47, No. 12, December, 1964, pp. 25-31, and Vol. 48, No. 1, January, 1965, pp. 24-28.

_____, "Coal Research in Canada, 1963", C.M.M.B., Vol. 57, No. 629, September, 1964, pp. 956-958.

_____, "The Nature of Coal Research", Proc., Fourteenth Dominion-Provincial Conference on Coal, Winnipeg, September 13-14, 1962, pp. 13-20.

_____, "Science in the Use of Coking Coals", Proc., Twelfth Annual Dominion-Provincial Coal Research Conference, Ottawa, October 13-15, 1960, pp. 81-93.

_____, "Towards a Carbochemical Industry", T.C.I.M.M., Vol. 56, 1953, pp. 273-280.

_____, E. M. Hadfield, and J. C. Wood, Active Carbons from Coal, Research Council of Alberta, Edmonton, 1965, 13 pp.

_____, and E. J. Jensen, "On Possibilities for Pipelining Coal in Canada", T.C.I.M.M., Vol. 66, 1963, pp. 258-262.

Bish, H. F., Manager, Whitewood Mine of Alberta Coal Ltd., pers. comm., Wabamun, September 7, 1965.

Bish, Walter, Superintendent, Forestburg Collieries Ltd., pers. comm., Forestburg, August 20, 1965.

"The Black Nugget Strip Mine", Western Miner, Vol. 22, No. 10, October 1949, pp. 160-161.

Botham, J. C., "Blending of Canadian Coals for the Manufacture of Metallurgical Coke", Proc., Twelfth Annual Dominion-Provincial Coal Research Conference, Ottawa, October 13-15, 1960, pp. 95-158.

Bourne, L. S. Yellowknife, N.W.T., unpublished M.A. thesis, University of Alberta, Edmonton, 1963, 160 pp.

Bridges, W. A., "Coal As a Raw Material for Chemical Products", Proc., Fifteenth Dominion-Provincial Conference on Coal, Halifax, September 19-20, 1963, pp. 44-50.

"A Brighter Future for Canadian Coal", Western Miner, Vol. 31, No. 11, November, 1958, pp. 76-83.

Brooks, R. R., "The Future of the Coal-fired Package Boiler", Proc., Fifteenth Domion-Provincial Conference on Coal, Halifax, September 19-20, 1963, pp. 51-61.

Brown, A., "Applications of Hydraulics to Mining", Proc., Thirteenth Annual Dominion-Provincial Coal Research Conference, Toronto, September 14-15, 1961, pp. 117-156.

_____, T. S. Cochrane, and T. H. Patching, "Ground Stress Studies in Coal Mines of Western Canada--A Progress Report", T.C.I.M.M., Vol. 61, 1958, pp. 364-375.

Brown, J. D. B., Assistant Director, The Mines Branch, Alberta Department of Mines and Minerals, pers. comm., Edmonton, October, 1964--March, 1966.

Bruckner, G., "Lignite Coke in Low-Shaft Blast Furnaces", Journal Of Metals, Vol. 8, No. 9, September, 1956, pp. 1160-1161.

Bucyrus-Erie Co., History of Development of Strip Mining Machines, South Milwaukee, Wisconsin, 1964, 16 pp.

Buehl, R. C., and M. B. Royer, "Low Fuel Rates with Coke-Anthracite Mixtures in 3-Ft. Blast Furnace", Journal of Metals, Vol. 8, No. 4, April, 1956, pp. 432-438.

Burton, J. T., "Geology of the Drumheller District", Western Miner, Vol. 21, No. 8, August, 1948, p. 160.

Calgary Power Ltd., Alberta-Province of Opportunity, Calgary, 1958, 321 pp.

_____, The Wabamun Dragline, Calgary, n. d., 12 pp.

Campbell, J. D., Catalogue of Coal Mines of the Alberta Plains, Research Council of Alberta, Preliminary Report 64-3, Edmonton, 1964, 140 pp.

_____, and I. S. Almadi, Coal Occurrences of the Vulcan-Gleichen Area, Alberta, Research Council of Alberta, Preliminary Report 64-2, Edmonton, 58 pp.

Canada, Report of the Royal Commission on Coal, 1946, King's Printer, Ottawa, 1947, 663 pp.

_____, Royal Commission on Canada's Economic Prospects, submission of The Coal Operators' Association of Western Canada, November 21, 1955, 44 pp.

_____, Royal Commission on Coal (1959), submission of Calgary Power Ltd., Calgary, March 31, 1960, 8 pp.

_____, Royal Commission on Coal (1959), submission of The Coal Operators' Association of Western Canada, Calgary, March 31, 1960, 52 pp.

_____, Royal Commission on Coal (1959), submission by the Dept. of Mines and Minerals, government of the Province of Alberta, Calgary, March 31, 1960, 12 pp.

_____, Royal Commission on Coal (1959), submission by District 18, United Mine Workers of America, Calgary, March 31, 1960, 23 pp.

_____, Royal Commission on Coal (1959), submission by The Drumheller Coal Operators' Association, Calgary, March 31, 1960, 20 pp.

_____, Royal Commission on Coal (1959), submission of The Western Canada Fuel Association, Calgary, April, 1960, 16 pp.

_____, Royal Commission on the Coal Industry of Canada. Submission on the Coal Resources and Coal Industry of Alberta, King's Printer, Edmonton, 1945, 137 pp.

_____, Royal Commission on Dominion-Provincial Relations, Submission of Western Canada Fuel Association, 1938, 48 pp.

_____, Royal Commission on Energy, submission of The Coal Operators' Association of Western Canada and The Western Canada Coal Utilization Council, Regina, April, 1958, 23 pp.

_____, Royal Commission on Energy, submission of the Joint Crow's Nest Pass Towns Committee, 1958, 4 pp.

_____, Royal Commission on Energy, First Report, Queen's Printer Ottawa, 1958, 98 pp.

_____, Royal Commission on Energy, Second Report, Queen's Printer, Ottawa, 1959, 189 pp.

_____, Submission to the Federal Cabinet by a delegation representing District 18 of the United Mine Workers of America, The Coal Operators' Association of Western Canada, other unattached coal companies, and the Provincial Governments of British Columbia, Alberta, and Saskatchewan, November 22, 1954, 42 pp.

Canadian Coal Committee, The Coal Question, Toronto, 1928, 10 pp.

"Canadian Markets for Canadian Coal", Western Miner, Vol. 24, No. 2, February, 1951, p. 86.

Cass-Beggs, David, "Coal and the National Grid", Proc., Fifteenth Dominion-Provincial Conference on Coal, Halifax, September 19-20, 1963, pp. 91-111.

_____, "Economic Feasibility of Trans-Canada Electrical Interconnection", The Engineering Journal, Vol. 44, No. 1, January 1961, pp. 53-57.

Chapman, John D., "Energy Problems in the Pacific Northwest", Yearbook of the Association of Pacific Coast Geographers, Vol. 24, 1962, pp. 53-63.

Charbonnier, R. P., "The Mobile Pipeline for the Transportation of Solids", Proc., Sixteenth Dominion-Provincial Conference on Coal, Lake Louise, September 3-4, 1964, pp. 67-80.

Chavignaud, L. G., "The Coal Seams of Alberta", Western Miner, Vol. 21, No. 8, August, 1948, p. 102.

_____, "Mercoal Mine Has Extensive Reserves of Quality Coal", Western Miner, Vol. 21, No. 8, August, 1948, pp. 68-69.

"A Chemical Industry for Alberta?", Western Miner, Vol. 22, No. 10, October, 1949, pp. 39-40.

Clow, W. H. A., and M. B. B. Crockford, Geology of Carbondale River Area, Alberta, Research Council of Alberta, Report No. 59, Edmonton, 1951, 70 pp.

"Coal-Burning Gas-Turbine Locomotive", Western Miner, Vol. 24, No. 1, January, 1951, p. 82.

Cochrane, T. S., "Metallurgical Coke", Western Miner, Vol. 24, No. 7, July, 1951, pp. 48-55.

Coleman Board of Trade, Coleman's Fiftieth Anniversary Booklet, Coleman, 1953, 71 pp.

"Coleman Collieries Ltd.", Western Miner, Vol. 35, No. 4, April, 1962, p. 79.

Connolley, John S., "Something Must be Done about Coal", Western Miner, Vol. 25, No. 10, October, 1952, pp. 78-80.

Constans, J. A. and F. E. Parkinson, "Pipelining Solids for Short Distances", Proc., Sixteenth Dominion-Provincial Conference on Coal, Lake Louise, September 3-4, 1964, pp. 44-66.

"Contractor and Operator", Western Miner, Vol. 21, No. 8, August, 1948, p. 170.

Convey, J., and S. L. Gertsman, "The Past, Present, and Future of the Canadian Steel Industry", T.C.I.M.M., Vol. 55, 1952, pp. 171-174.

Cooney, V. A., "The Greatness of Coal", Western Miner, Vol. 21, No. 9, September, 1948, pp. 58, 60, 62.

Cormack, R. G. H., Forest Conservation Studies in Alberta, 1944-1952, University of Alberta, Edmonton, n. d., 5 parts.

Cousins, William James, A History of the Crow's Nest Pass, unpublished M.A. thesis, University of Alberta, Edmonton, 1952, 214 pp.

Cowie, N. F., "The Role for Railways in Western Canada", Proc., Sixteenth Dominion-Provincial Conference on Coal, Lake Louise, September 3-4, 1964, pp. 7-16.

Crawford, Hugh, general manager, Amalgamated Coals Ltd., East Coulee, pers. comm., East Coulee, August 4, 1965.

Crawford, Ian D., The Geology and Strucutre of the Lethbridge Coal Field, unpublished M. Sc., thesis, University of Alberta, Edmonton, 1947, 131 pp.

Crawford, John, "Alberta Coal Output in 1948", Western Miner, Vol. 22, No. 4, April, 1949, pp. 92-93.

Crawford, Margaret E., A Geographical Study of the Distribution of Population Changes in Alberta, unpublished M.A. thesis, University of Alberta, Edmonton, 1962, 122 pp.

Crockford, M. B. B., Geology of Kootenay Coal Measures in Southwestern Alberta, T.C.I.M.M., Vol. 52, 1949, pp. 69-75.

_____, Geology of Ribbon Creek Area, Alberta, Research Council of Alberta, Report No. 52, Edmonton, 1949, 64 pp.

_____, Oldman and Foremost Formations of Southern Alberta, Research Council of Alberta, Contribution 16, Edmonton, 1949, 11 pp.

Danyluk, M., immediate past president of the Drumheller Chamber of Commerce, pers. comm., Drumheller, August 5, 1965.

Davis, John, Canadian Energy Prospects, Royal Commission on Canada's Economic Prospects, Ottawa, 1957, 392 pp.

Dawson, George M., "On the Geology of the Region Between the 54th and 56th Parallels, from the Pacific Coast to Edmonton", Geological and Natural History Survey of Canada, Report of Progress for 1879-80, Ottawa, pp. 99-142.

_____, "Preliminary Report on the Geology of the Bow and Belly River Region, North-West Territory, with Special Reference to the Coal Deposits", Geological and Natural History Survey of Canada, Report of Progress, 1880-81-82, Ottawa, Part B, pp. 1-23.

_____, "Preliminary Report on the Physical and Geological Features of that Portion of the Rocky Mountains Between Latitudes 49° and 50°30'", Geological and Natural History Survey of Canada, Annual Report, Vol. 1 (1885), Part B, 169 pp.

Deasy, George F., and Phyllis R. Griess, "Geographical Significance of Recent Changes in Mining in the Bituminous Coal Fields of Pennsylvania", Econ. Geogr., Vol. 33, 1957, pp. 283-298.

Diller, Dorothy, The Early Economic Development of Alberta (Previous to 1905), unpublished M.A. thesis, University of Alberta, Edmonton, 1923, 161 pp.

Doerr, Arthur, and Lee Guernsey, "Man as a Geomorphological Agent: The Example of Coal Mining". A.A.A.G., Vol. 46, No. 2, June, 1956, pp. 197-210.

Dominion Bureau of Statistics, Canadian Mineral Statistics 1886-1956, Minister of Trade and Commerce, Reference Paper No. 68, Ottawa, 1957, 120 pp.

Dominion-Provincial Coal Conference, Proc., Ninth Annual Conference, Research Council of Alberta, Mimeographed Circular No. 24, Edmonton, 1957, 124 pp.

Dowling, D. B., "Bow River Coal Basin Within the Rocky Mountains, Alberta", Summ. Report, G.S.C., 1923, Part B, pp. 63-85.

_____, Cascade Coal Basin, G.S.C., Ottawa, 1907, 37 pp.

_____, "On the Coal Basins in the Rocky Mountains, Sheep Creek and Cascade Troughs Northward to the Panther River", Summ. Report, G.S.C., 1903, pp. 83-91.

_____, "Coal Fields of the Grand Trunk Pacific Railway in the Foothills of the Rocky Mountains, Alberta", Summ. Report, G.S.C., 1909, pp. 139-150.

_____, "Coal Fields of Jasper Park, Alberta", Summ. Report, G.S.C., 1910, pp. 150-168.

_____, The Coal Fields of Manitoba, Saskatchewan, Alberta, and Eastern British Columbia, Department of Mines, Geological Survey Branch, Ottawa, 1909, 111 pp.

_____, The Edmonton Coal Fields, Department of Mines, Geological Survey Branch, Memoir No. 8-E, 1910, 53 pp.

_____, "Explorations in the Rocky Mountains", Summ. Report, G.S.C., 1907, pp. 32-34.

_____, "Geology of Roche Miette Map-area, Jasper Park, Alberta", Summ. Report, G.S.C., 1911, pp. 201-219.

_____, "Investigations for Coal, Oil, Gas, and Artesian Water in Western Canada", Summ. Report, G.S.C., 1916, pp. 76-85.

_____, "North Saskatchewan Coal Areas, Alberta", Summ. Report, G.S.C., 1913, pp. 150-152.

_____, "Notes on Coal Occurrences and the Progress of Development Work in Alberta and Saskatchewan", Summ. Report, G.S.C., 1911, pp. 219-224.

_____, "Rocky Mountain Coal Areas", Summ. Report, G.S.C., 1916, pp. 66.73.

_____, "Steam Coals of the Cascade Basin. Lignite Areas of Alberta and Saskatchewan. Production of Coal in Alberta and Saskatchewan", Summ. Report, G.S.C., 1908, pp. 77-86.

Draper, Herbert L., The Alberta Coal Problem, Dept. of Economics and Political Science, McGill University, Montreal, 1930, 65 pp.

Dunbar, Carl O., Historical Geology, Wiley, New York, 1960, 500 pp.

Dunn, A. C. "The Black Diamond Mine", Western Miner, Vol. 22, No. 4, April, 1949, p. 97.

Dunn, J. S. C., and W. A. Lang, Performance of Typical Alberta Coal in a Rotating-Grate Domestic Stoker, Research Council of Alberta, Mimeographed Circular No. 17, 1954, 29 pp.

Dupret, L., "Cleaning and Drying Fine Coal", Western Miner, Vol. 27, No. 4, April, 1954, pp. 38-40.

Dwarkin, L. M., "Optimum Strip Ratio for Pitching Seams", C.M.M.B., Vol. 42, No. 446, July, 1949, pp. 354-359.

Estall, R. C., "The Problem of Power in the United Kingdom", Econ. Geogr., Vol. 34, 1958, pp. 80-89.

Ewart, T. G., Japan--Export Market for Western Canadian Bituminous, address to the Calgary Branch, C.I.M.M., January 28, 1964, 8 pp.

_____, "Western Coking Coal Reserves", T.C.I.M.M., Vol. 55, 1952, pp. 164-166.

Farrell, Bryan H., Power in New Zealand, A. H. and A. W. Reed, Wellington, 1962, 197 pp.

Ford, J. N. and W. I. McFarland, "Battle River Steam Station", The Engineering Journal, Vol. 41, No. 1, January, 1958, pp. 49-57, 78-79, 92.

Fraser, A. A., "Pioneer Strip Mines of Alberta", Western Miner, Vol. 21, No. 8, August, 1948, pp. 50-52.

Fumich, George, "The United States Office of Coal Research Program", Proc., Sixteenth Dominion-Provincial Conference on Coal, Lake Louise, Sept. 3-4, 1964, pp. 184-195.

"The Future of Coal", Western Miner, Vol. 31, No. 7, July, 1958, pp. 37-39.

Gardner, H. H., "Adapting Duckbills to Entry Driving at Greenhill Mines", T.C.I.M.M., Vol. 50, 1947, pp. 353-361.

_____, "Possibilities of Continuous Mining in the Pitching Coal Seams of Western Canada", T.C.I.M.M., Vol. 61, 1958, pp. 138-141.

Gerow, T. G., "The Strip Mine of the Future", Proc., Sixteenth Dominion-Provincial Conference on Coal, Lake Louise, Sept. 3-4, 1964, pp. 137-148.

Grace, N. H., "Coal--Today and Tomorrow", Western Miner, Vol. 30, No. 10, October, 1957, pp. 53-64.

_____, "Energy from Coal in Western Canada", T.C.I.M.M., Vol. 56, 1953, pp. 37-42.

_____, "Future of Coal in Western Canada", Western Miner, Vol. 28, No. 4, April, 1955, pp. 38-39.

Gray, F. W., "Canada and Coal", C.M.M.B., Vol. 37, 1944, pp. 53-58.

_____, "Canada and Coal", Western Miner, Vol. 24, No. 2, February, 1951, pp. 44-46.

Green, R., "Brazeau Collieries Limited, Nordegg, Alberta", Guide Book, Eighth Annual Field Conference, Alberta Society of Petroleum Geologists, Aug. 1958, pp. 5-9.

Gregory, J., and A. McCulloch, "Low Temperature Carbonization of Alberta Subbituminous Coal", Industrial and Engineering Chemistry, Vol. 41, 1949, pp. 1003-1011.

Griffin, John, "How High Grade Iron Ores and Agglomerates Will Affect Coke Rates", Journal of Metals, Vol. 8, No. 4, April, 1956, pp. 439-442.

Guernsey, Lee, "The Reclamation of Strip Land in Western Kentucky", The Journal of Geography, Vol. 59, No. 1, January, 1960, pp. 5-11.

Hammett, W. L., "Foothills' Reaches All Canada", Western Miner, Vol. 21, No. 8, August, 1948, pp. 92, 94.

Hardie, W. D. L., "The Galt Coal Field, Alberta", The Journal of The Canadian Mining Institute, Vol. 13, 1910, pp. 190-195.

Harding, G. E., "American Coal Production and Use", Econ. Geogr., Vol. 22, 1946, pp. 46-53.

Harle, J. A., "Thermal Power for Alberta", T.C.I.M.M., Vol. 54, 1951, pp. 447-451.

Hawkins, Claude, superintendent, Wabamun Station, Calgary Power Ltd., pers. comm., Wabamun, Sept. 7, 1965.

Henderson, J. M., The Efficiency of the Coal Industry, Harvard University Press, Cambridge, 1958, 146 pp.

Henretta, C. M., "Bankhead Coal Mine", The Journal of the Canadian Mining Institute, Vol. 8, 1905, pp. 215-220.

Hibbert, W., "Pioneer of Drumheller", Western Miner, Vol. 21, No. 8, August, 1948, pp. 78-79.

Hnatyshyn, Andrew C., General superintendent, Amalgamated Coals Ltd., pers. comm., East Coulee, Aug. 5, 1965.

_____, "Century Is Important Exporter", Western Miner, Vol. 21, No. 8, August, 1948, pp. 84-86.

Hollies, R. T., Preliminary Investigations on Weathering of Alberta Coals, unpublished M.Sc. thesis, University of Alberta, Edmonton, 1921, 59 pp.

Hubbert, M. King, Energy Resources, National Academy of Sciences-National Research Council, publication 1000-D, Washington, 1962, 141 pp.

Hutt, G. McL., and E. Swartzman, "Canadian Consumption of Industrial Coals", T.C.I.M.M., Vol. 61, 1958, pp. 17-24.

Ignatieff, A., "Underground Gasification of Coal: A Review of Progress", T.C.I.M.M., Vol. 52, 1949, pp. 265-271.

_____, A. Brown, and F. L. Casey, "Conditions and Occurrences in the Canadian Coal Mining Industry", Canadian Mining Journal, Vol. 72, No. 10, October, 1951, pp. 67-75.

Industrial Federation of Labour, Canadian Congress of Labour, A Declaration on Western Canadian Coal, Calgary, 1950, 8 pp.

Innis, Harold A., Settlement and the Mining Frontier, Macmillan, Toronto, 1936, 247 pp.

"Innovations in Coal Mining", Western Miner, Vol. 22, No. 2, February, 1949, pp. 52-53.

Irving, F. L., "A Highly Mechanized Strip Mine", Western Miner, Vol. 21, No. 8, August, 1948, p. 100.

Janes, T. H., "Iron Ore and Other Raw Material Sources for a Primary Iron and Steel Industry in Western Canada", T.C.I.M.M., Vol. 61, 1958, pp. 314-323.

Jensen, E. J., and J. F. Fryer, An Investigation of the Grindability of Alberta Subbituminous Coals, Research Council of Alberta, Mimeographed Circular No. 26, Edmonton, 1958, 38 pp.

Jones, Stephen B., "Mining and Tourist Towns in the Canadian Rockies", Econ. Geogr., Vol. 9, 1933, pp. 368-378.

Laffen, John J., "Residential Electric Space Heating", Proc., Fourteenth Dominion-Provincial Conference on Coal, Winnipeg, September 13-14, 1962, pp. 95-104.

Laleune, H., head, coal mine operations, Whitewood Mine, Calgary Power Ltd., pers. comm., Wabamun, September 7, 1965.

Landsberg, Hans H., Resources in America's Future, Johns Hopkins Press for Resources for the Future, Inc., Baltimore, 1963, 1017 pp.

Lang, W. A., "Alberta's Industrial Development Is Assisted by Modern Research", Western Miner, Vol. 21, No. 8, August, 1948, pp. 75-77.

_____, The Briquetting of Alberta Coals, Research Council of Alberta, Contribution 22, Edmonton, 1950, 9 pp.

_____, Fuel Investigations of the Research Council of Alberta, 1919-1940, Research Council of Alberta, Contribution 1, Edmonton, 1941, 18 pp.

_____, "Progress in Coal Technology: Gasification and Chemical Utilization", T.C.I.M.M., Vol. 55, 1952, pp. 108-112.

_____,"Utilization of Alberta Sub-Bituminous Coal:, T.C.I.M.M., Vol. 61, 1958, pp. 307-313.

Leach, W. W., "The Blairmore-Frank Coal-fields", Summ. Report, G.S.C., 1902, pp. 169-181.

"A Leading Coal Branch Producer", Western Miner, Vol. 21, No. 8, August, 1948, pp. 66-67.

Lewis, John W., Further Investigations of Some of the Properties of Alberta Coals, unpublished M.Sc. thesis, University of Alberta, Edmonton, 1921, 33 pp.

Livingstone, R. D., "Alberta's Pioneer Coal Producer", Western Miner, Vol. 21, No. 8, August, 1948, pp. 59-61.

_____, Mechanized Mining Reports, Western Mechanized Mining Commission, Lethbridge, 1948, 208 pp.

_____, and J. S. Webster, "Shaker Conveyors at the Standard Mine, Lethbridge", Western Miner, Vol. 24, No. 10, October, 1951, pp. 28-36.

London, W. P., A. C. Shamess, and A. Smillie, "Long Distance Transmission of Electric Energy from Pit-head Generating Stations vs. Transportation of Coal for Conversion at Distant Stations", Proc., Thirteenth Annual Dominion-Provincial Coal Research Conference, Toronto, Sept. 14-15, 1961, pp. 95-113.

"A Long Record of Achievement", Western Miner, Vol. 21, No. 8, August, 1948, pp. 70-71.

MacGregor, James G., Chairman, Alberta Power Commission, pers. comm., Edmonton, March 2, 1965.

_____, "Coal for Electricity in Alberta", paper presented to Sixteenth Dominion-Provincial Conference on Coal, Lake Louise, Sept. 3-4, 1964, pp. 196-202.

MacKay, B. R., "Brûlé Mines Coal Area, Alberta", Summ. Report G.S.C., 1928, Part B, pp. 1-29.

_____, Coal Reserves of Canada, King's Printer, Ottawa, 1946, 113 pp.

_____, "Geology and Coal Deposits of Crwosnest Pass Area, Alberta", Summ. Report, G.S.C., 1932, Part B, pp. 21-67.

_____, "Stratigraphy and Structure of Bituminous Coalfields in the Vicinity of Jasper Park, Alberta", T.C.I.M.M., Vol. 33, 1930, pp. 473-509.

Mackenzie, John D., "South Fork Coal Area, Oldman River, Alberta", Summ. Report, G.S.C., 1912, pp. 235-246.

MacKinnon, H. G., "Murray Collieries Has Fine Record", Western Miner, Vol. 21, No. 8, August, 1948, p. 65.

MacVicar, John, "Coal Areas Northwest of Brûlé Lake, Alberta", Summ. Report, G.S.C., 1919, Part C, pp. 8-13.

_____, "Foothill Coal Areas North of the Grand Trunk Pacific Railway, Alberta", Summ. Report, G.S.C., 1916, pp. 85-93.

_____, The Origin Composition, and Occurrence of Coal in Alberta, unpublished M.Sc. thesis, University of Alberta, Edmonton, 1916, 129 pp.

_____, "Preliminary Investigations of Coal Deposits on Smoky, Hay, and Berland Rivers, Alberta", Summ. Report, G.S.C., 1923, Part B, pp. 21-62.

Malloch, G. S., "The Cascades, Palliser, and Costigan Coal Basins", Summ. Report, G.S.C., 1907, pp. 34-40.

McAndrew, R. T., "Coal Mining at Drinnan, Alberta", C.M.M.B., Vol. 24, 1931, pp. 1375-1395.

McBride, R. D., mine manager, Battle River Coal Co. Ltd., pers. comm., Halkirk, August 20, 1965.

McCulloch, A. and E. Sherlock, "Graphical Studies of the Properties of Alberta Coals", Fuel, Vol. 28, No. 6, June, 1949, pp. 135-141.

McEvoy, James, "On the Geology and Natural Resources of the Country Traversed by the Yellowhead Pass Route from Edmonton to Tête Jaune Cache", Summ. Report, G.S.C., 1898, Part D, pp. 1-44.

McMullen, A., "Canada's Largest Briquetting Operation", Western Miner, Vol. 21, No. 8, August, 1948, pp. 62-64.

Melnyk, N., and W. A. Lang, The "Coal-Pak" and Its Application to Alberta Coals, Research Council of Alberta, Contribution 84, Edmonton, 1958, 18 pp.

Miard, H. E., "Sudden Releases of Ground Stresses in the Coal Mines of Western Canada", T.C.I.M.M., Vol. 56, 1953, pp. 219-224.

Miller, E. Willard, "Penn Township--An Example of Local Governmental Control of Strip Mining in Pennsylvania", Econ. Geogr., Vol. 28, 1952, pp. 256-260.

Miller, H., "Hillcrest Mohawk Collieries", Western Miner, Vol. 21, No. 8, August, 1948, pp. 87-88.

Miller, J. G., "The Briquetting of Coal", Western Miner, Vol. 26, No. 3, March, 1953, pp. 36-37.

Minagawa, Hiro, "Japanese Markets for Canadian Minerals", Western Miner, Vol. 33, No. 11, November, 1960, pp. 33-38.

Mordell, Donald L., "Present Position and Prospects of a Coal Burning Gas Turbine", T.C.I.M.M., Vol. 55, 1952, pp. 74-78.

Moreland, C., "Low Temperature Fluidized Carbonization in Relation to Energy Production", T.C.I.M.M., Vol. 61, 1958, pp. 225-229.

Morgan, G., and E. D. Hollup, "Progress in Coal-fired Steam Stations", Proc., Thirteenth Dominion-Provincial Coal Research Conference, Toronto, Sept. 14-15, 1961, pp. 37-48.

Morgan, Owen, "Bighorn and Saunders", Western Miner, Vol. 21, No. 8, August, 1948, p. 96.

Morris, J. E., "Developments in Steep Seam Mining", Proc., Sixteenth Dominion-Provincial Conference on Coal, Lake Louise, Sept. 3-4, 1964, pp. 149-170.

Murphy, Raymond E., and Marion Murphy, "Anthracite Region of Pennsylvania", Econ. Geogr., Vol. 14, 1938, pp. 338-348.

Murphy, Raymond E., and Hugh E. Spittal, "Movements of the Center of Coal Mining in the Appalachian Plateaus", Geogr. Review, Vol. 35, 1945, pp. 624-633.

_____, "A New Production Map of the Appalachian Bituminous Coal Region", A.A.A.G., Vol. 34, 1944, pp. 164-172.

Nelson, W. I., "Sources of Coal Supply for the Granby Plant", Western Miner, Vol. 21, No. 12, December, 1948, p. 75.

Norris, D. K., Structural Conditions in Canadian Coal Mines, G.S.C. Bulletin 44, Ottawa, 1958, 54 pp.

_____, "Structural Conditions in Coal Mines of the Canmore Area, Alberta", Guide Book, Sixth Annual Field Conference, Alberta Society of Petroleum Geologists, August, 1956, pp. 59-65.

Nova Scotia, Department of Mines and Nova Scotia Research Foundation, Conference on the Origin and Constitution of Coal, Crystal Cliffs, Nova Scotia, 1950, 159 pp.

Oberholtzer, J. E., "The Role of Non Metallic Minerals and Coal in the Industrialization of Western Canada", T.C.I.M.M., Vol. 56, 1953, pp. 228-232.

O'Brian, C. L., "Canadian Energy Sources", T.C.I.M.M., Vol. 56, 1953, pp. 161-181.

_____, "Coal in 1950: Particularly the Domestic Market", T.C.I.M.M., Vol. 54, 1951, pp. 346-353.

_____, and A. W. Lovett, "Energy in Western Canada", T.C.I.M.M., Vol. 59, 1956, pp. 289-304.

_____, and A. W. Lovett, "Present Status of Canadian Energy", T.C.I.M.M., Vol. 62, 1959, pp. 310-317.

Panchysyn, E., chief engineer, Alberta Coal Ltd., pers. comm., Calgary, August 19, 1965.

Patching, T. H., Professor of Mining and Metallurgy, University of Alberta, pers. comm., Edmonton, May 14, 1965.

Patrick, Omer H., general manager, Amalgamated Coals, pers. comm., East Coulee, August 5, 1965.

Pattinson, C., "Freight Rates and the Coal Mining Industry", Western Miner, Vol. 24, No. 3, March, 1951, pp. 42-45.

Pearson, G. Raymond, The Clover Bar Coal Zone, Research Council of Alberta, preliminary report 61-1, Edmonton, 1961, 26 pp.

_____, Coal Reserves for Strip-Mining, Wabamun Lake District, Alberta, Research Council of Alberta, preliminary report, 59-1, Edmonton, 1959, 55 pp.

_____, Evaluation of Some Alberta Coal Deposits, Research Council of Alberta, preliminary report 60-1, Edmonton, 1960, 61 pp.

Peel, Bruce, "The Coal Fleet", Alberta Historical Review, Vol. 12, No. 4, Autumn, 1964, pp. 8-14.

Perry, Harry, "Coal Research in the United States", Proc., Fifteenth Dominion-Provincial Conference on Coal, Halifax, September 19-20, 1963, pp. 35-43.

Potter, C. J., "Coal: Past, Present, Future", Western Miner, Vol. 24, No. 11, November, 1951, pp. 47-51.

Powell, A. R. "Gas from Coal Carbonization--Preparation and Properites", pp. 921-946 in Chemistry of Coal Utilization, prepared by National Research Council, John Wiley and Sons, New York, 1945.

"Power Development Programme", Western Miner, Vol. 27, No. 11, November, 1954, p. 71.

Prudham, George, "Canada's Coal Policy", Western Miner, Vol. 26, No. 8, August, 1953, pp. 39-41.

Pullen, P. F., and R. Tennant, "Alexo Has Quality Products", Western Miner, Vol. 21, No. 8, August, 1948, pp. 88-89.

Purves, Donald F., "Coal Transportation in Canada", Proc., Fifteenth Dominion-Provincial Conference on Coal, Halifax, September 19-20, 1963, pp. 7-15.

Rand, I. C., Report of the Royal Commission on Coal, Queen's Printer, Ottawa, 1960, 127 pp.

"Revolutionary Coal Mining Method", Western Miner, Vol. 37, No. 3, March 1964, p. 36.

Richter, L., "Canada's Coal Problem", The Canadian Banker, Vol. 54, No. 2, May, 1947, pp. 30-42.

Riva, W. J., vice-president, The Canmore Mines Ltd., pers. comm., June 23, 1965.

_____, "Metallurgical Coke from High-Carbon Coals", Western Miner, Vol. 36, No. 4, April, 1963, pp. 28-33.

Rose, B., "Structure in the Crowsnest Coal Area, Alberta", T.C.I.M.M., Vol. 27, 1924, pp. 609-619.

Ross, D. W. M., "Coal Loaders in Alberta", Western Miner, Vol. 21, No. 11, November, 1948, pp. 104, 106.

Rudd, R. D., "The Red Ember Coal Mine: An Illinois Stripping Operation", The Journal of Geography, Vol. 59, No. 1, January, 1960, pp. 11-15.

Sall, George W., "Advancing Technology Saves an Industry", Proc., Sixteenth Dominion-Provincial Conference on Coal, Lake Louise, September 3-4, 1964, pp. 95-111.

Sands, Mark, owner and operator, Subway Coal Company, pers. comm., Rosedale, August 5, 1965.

Saunders, George S., "Technological Change and Industrial Relations", Proc., Sixteenth Dominion-Provincial Conference on Coal, Lake Louise, September 3-4, 1964, pp. 81-94.

Sayers, D. P., and A. E. Hawkins, "Power Generation in Great Britain with Special Reference to the Influence of Coal Resources on Planning", Proc., Tenth Annual Dominion-Provincial Coal Research Conference, St. Andrews, New Brunswick, September 1-2, 1958, Part I, 46 pp.

Schmidt, L. D. "Changes in Coal During Storage", pp. 627-676 in Chemistry Of Coal Utilization, prepared by the National Research Council, John Wiley and Sons, New York, 1945.

Schneider-Paas, Arno, and Hans Osthof, "Modern Longwall Mining Techniques", Proc., Sixteenth Dominion-Provincial Conference on Coal, Lake Louise, September 3-4, 1964, pp. 171-183.

Schurr, Sam H., and Bruce C. Netschert, Energy in the American Economy, 1850-1975, Johns Hopkins Press for Resources for the Future, Inc., Baltimore, 1960, 774 pp.

Shand-Harvey, James, pers. comm., Old Entrance, Alberta, June 19, 1965.

Sherlock, E., "A Classification of Alberta Coals", Fuel, Vol. 28, No. 12, December, 1949, pp. 276-281.

Smith, Frank B., "Coal Mining in the North West Territories and its Probable Future", Journal of the Canadian Mining Institute, Vol. 5, 1902, pp. 104-112.

_____, "Mining in the North-West, 1902", Journal of the Canadian Mining Institute, Vol. 6, 1903, pp. 373-375.

Smith, Terry, "Mechanization at Western Monarch", T.C.I.M.M., Vol. 60, 1957, pp. 52-53.

_____, "Monarch is Completely Mechanized", Western Miner, Vol. 21, No. 8, August, 1948, pp. 80-81.

Soen, Frank P., "Rail Transportation of Coal in the United States", Proc., Fifteenth Dominion-Provincial Conference on Coal, Halifax, September 19-20, 1963, pp. 16-23.

Stamp, L. Dudley, "Britain's Coal Crisis", pp. 466-478 in Outside Readings in Geography, ed. by F. E. Dohrs, L. M. Sommers, and D. R. Petterson, Thomas Y. Crowell, New York, 1955.

Stanley, T. D., production superintendent, Calgary Power Ltd., pers. comm., Calgary, August 19, 1965.

Stansfield, Edgar, and W. A. Lang, Coals of Alberta: Their Occurrence, Analysis, and Utilization, Research Council of Alberta, Report No. 35, Edmonton, 1944, 174 pp.

Statham, I. C. F., Coal Mining, English Universities Press, London, 1951, 564 pp.

Stephens, F. H., "The Foothills Province", Western Miner, Vol. 21, No. 8, August, 1948, pp. 56-57.

Stewart, J. S., "Coal Mines of West Central Alberta", Summ. Report, G.S.C., 1916, pp. 94-106.

"Strip Mining Coal Machinery", Western Miner, Vol. 27, No. 10, October, 1954, pp. 108-109.

Stutzer, Otto, and Adolph C. Noé, Geology of Coal, The University of Chicago Press, Chicago, 1940, 461 pp.

Swartzman, E., Analysis Directory of Canadian Coals, Fuels Division, Dept. of Mines and Technical Surveys, Ottawa, 1953, 204 pp.

Tanner, N. E., "Coal Must Play Its Part", Western Miner, Vol. 23, No. 12, December, 1950, pp. 51-53.

Thomas, Trevor M., "Recent Trends and Developments in the British Coal Mining Industry", Econ. Geogr., Vol. 34, 1958, pp. 19-41.

Thompson, G. H., "Coal vs. Natural Gas at Wabamun", The Journal of Canadian Petroleum Technology, Vol. 1, No. 4, winter, 1962, pp. 180-183.

Trace, Harry D., An Examination of Some Factors Associated with the Decline of the Coal Industry in Alberta, unpublished M.A. thesis, University of Alberta, Edmonton, 1958, 107 pp.

Tryon, F. G., and W. F. McKenney, "Geographical Shifts in Coal Production", Coal Age, Vol. 19, No. 3, January 20, 1921, pp. 106-109.

Tweeddale, R. E., "Factors Related to the Interconnection of Regional Power Systems", Proc., Tenth Annual Dominion-Provincial Coal Research Conference, St. Andrews, New Brunswick, September 1-2, 1958, Part I, 28 pp.

_____, "Pitheads vs. Load Centers As Locations For Power Plants", Proc., Fifteenth Dominion-Provincial Conference on Coal, Halifax, September 19-20, 1963, pp. 112-119.

Tyrrell, J. B., "Report on a Part of Northern Alberta and Portions of Adjacent Districts of Assiniboia and Saskatchewan", Annual Report G.S.C., 1886, Vol. II, Part E., 176 pp.

United States Bureau of Mines, Mineral Facts and Problems, 1960, Washington, 1960, 1015 pp.

United States Bureau of Mines, Mineral Facts and Problems, 1965, Washington, 1965, 1118 pp.

Upton, R., secretary-treasurer, Coleman Collieries Ltd., pers. comm., Coleman, August 6, 1965.

Uren, W. E., "Canadian Coal in the Years Ahead", Western Miner, Vol. 27, No. 11, November, 1954, pp. 64-67.

_____, "Operating Costs and Revenues of Canadian Coal Mines", Western Miner, Vol. 30, No. 11, November, 1957, p. 92.

_____, "Operating Costs and Revenues of Canadian Coal Mines", Western Miner, Vol. 33, No. 10, October, 1960, p. 97.

Ushiba, Nobuhiko, "Japan's Mineral Requirements", Western Miner, Vol. 37, No. 3, March, 1964, pp. 24-25.

Visman, J. "The Status of Coal Mining in Western Canada", T.C.I.M.M., Vol. 57, 1954, pp. 13-21.

Vissac, G. A., and R. P. Charbonnier, "Comparison of Canadian Energy Prospects--Potential of Coal-in-Oil Fuels", The Engineering Journal, Vol. 47, No. 4, April, 1964, pp. 23-28.

Voskuil, Walter H., "Bituminous Coal Movements in the United States", Geogr. Review, Vol. 32, 1942, pp. 117-127.

Walsh, J. H., "The Role of Canadian Coal in the Iron and Steel Industry in Western Canada", Proc., Eleventh Annual Dominion-Provincial Coal Research Conference, Saskatoon, September 10-12, 1959, pp. 46-61.

_____, J. C. Botham, and H. P. Hudson, "Present and Potential Uses for Coal in the Canadian Metallurgical Industry", T.C.I.M.M., Vol. 61, 1958, pp. 57-64.

Warkentin, John, The Western Interior of Canada, McLlelland and Stewart, The Carleton Library No. 15, Toronto, 1964, 304 pp.

Water Resources Branch, Dept. of Northern Affairs and National Resources, Electric Power in Canada 1964, Ottawa, 1965, 114 pp.

"West Canadian Modernizes Mines and Tipples", Western Miner, Vol. 23, No. 4, April, 1950, pp. 81-82.

"The Western Coal Problem", Western Miner, Vol. 23, No. 10, October, 1950, pp. 47-50.

Whittaker, W. C., Managing Director, Coal Operators' Association of Western Canada, pers. comm., Calgary, August 19, 1965.

_____, "Coal", Western Miner, Vol. 38, No. 3, March, 1965, p. 39.

_____, "The Interdependence of Coal and Bulk Carriers", Proc., Sixteenth Dominion-Provincial Conference on Coal, Lake Louise, September 3-4, 1964, pp. 17-43.

Wickenden, R. T. D., "Coal Deposits of the Southern Rocky Mountains of Canada", Guide Book, Fourth Annual Field Conference, Alberta Society of Petroleum Geologists, August, 1954, pp. 149-153.

Wiggan, G. A. "Kleenbirn Record Is Impressive", Western Miner, Vol. 21, No. 8, August, 1948, pp. 72-74.

Williams, M. M., "Coal in Western Canada and Its Uses", T.C.I.M.M., Vol. 61, 1958, pp. 242-249.

_____, and C. F. Doerr, Power from Coal at Wabamun, Calgary Power Ltd., Calgary, 1962, 15 pp.

Wilson, M. G. A., "Recent Trends in the Coal Industry of New South Wales", The Australian Geographer, Vol. 8, No. 4, March, 1962, pp. 173-182.

Wilton-Clark, H., "Coal Preparation Progress in Western Canada", T.C.I.M.M., Vol. 55, 1952, pp. 69-73.

Woods, J. D., and Gordon Limited of Toronto, Survey of the Market for Underground Mined Coal, prepared for the Coal Operators' Association of Western Canada, March, 1953, 24 pp.

_____, Survey of the Market for Underground Mined Coal, prepared for the Coal Operators' Association of Western Canada, June, 1956, 46 pp.

Young, James W., "Coal Consumption in Western Canada, 1951-1960", Occasional Papers of the British Columbia Division, C.A.G., No. 4, June, 1963, pp. 59-74.

University of Alberta Library
0 1620 1592 6239

B29847